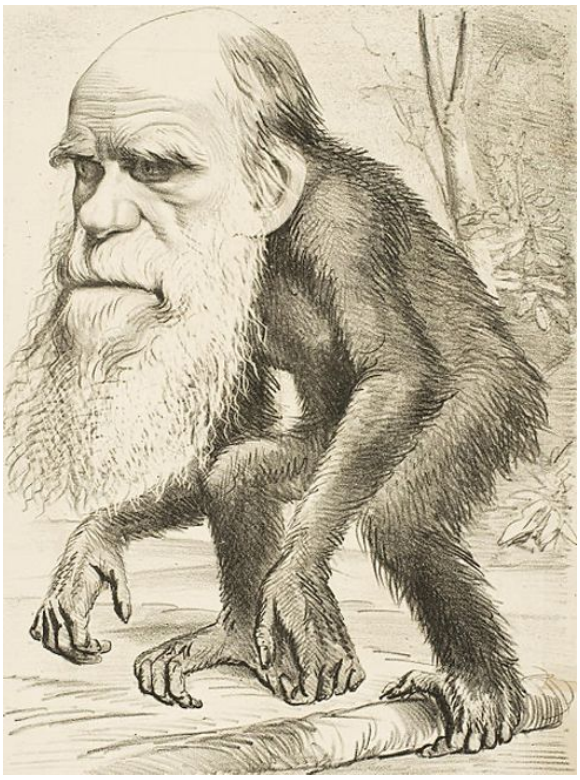
Homo Neanderthalensis Foodways

Summary



In the year 1856, just three years before Darwin's "On the Origin of Species" would make its debut, sending waves of controversy throughout the scientific, philosophical, and religious sectors of society due in part to its implication that human beings were descendants of an 'ape-like progenitor', workers of a limestone quarry made a discovery that would send ripples of contention through the scientific community and beyond into mainstream society for the decades to come. Buried amidst the clay embedded in a cave, the quarry workers had found a skeleton that resembled that of a human, but with obvious differences from that of a modern European. In time, this skeleton would make its mark in history, giving birth to an entire scientific discipline known as paleoanthropology that seeks to unearth the story of ancient man through discovered fossils and footprints. This particular fossil, the first one to be eventually recognized as that of an ancient human, would come to be known as "Neanderthal I," named after the "Neander Valley" of Germany it was discovered in.

"A Venerable Orang-outang", a caricature of Charles Darwin as an ape published in The Hornet, a satirical magazine on March 22, 1871. This photo is in the public domain: http://en.wikipedia.org/wiki/File:Editorial_cartoon_depicting_Charles_Darwin_as_an_ape_(1871).jpg.

At first, many speculated that the skeleton was that of an old foreign soldier from the Napoleonic wars of the early 19th century who had been badly malformed from battle. Still others proposed that perhaps it was the skeleton of a diseased human who had developed thick brow ridges from a constant furrowing of the brow due to the pain endured from disease. The quarry workers themselves were convinced that they had unearthed the bones of a cave bear. However, upon further examination observations were made that ruled out the possibility for this skeleton to be classified as either a cave bear or a modern human, leaving the scientists with an unsolved mystery to be resolved.

With no previous fossils of prehistoric humans yet recognized by the scientific community, taking the leap to define this newly discovered human-like skeleton as a human relative that modern man somehow shared a line of ancestry with would have likely been too controversial at the time to have been accepted. Thus, in an attempt to offer an adequate interpretation of the pending conundrum, the scientists settled with an explanation that the skeleton was more ape-like than human, and that it was not a close ancestor to the modern European, but rather, may have been from a previously unknown, very ancient, barbarous and savage race of humans very different from modern man. This conclusion was generally accepted, and would come to pervade future scientists' preconceptions of similar skeletons uncovered in the following decades. Together these preconceptions would come to paint a primitive, ape-like portrayal of the Neanderthal so that from its first years of discovery on, Neanderthals would take on the popular depiction of a slow, dim-witted brute with a slouched ape-like gait, a hairy outer covering, and an affinity for caves.

Thus was born the archetypal character of the cave man, an image that would survive all the way through to modern day so that the common stereotype of the Neanderthal as a brutish, unintelligent, and hairy caveman still pervades popular culture today. With this inelegant form of a man representing the Neanderthal, it became most unappealing to claim the Neanderthal as an ancient relative to modern humans. To this day, Neanderthal's relation to modern man is a point of debate with some arguing that the Neanderthals are very close kin to modern man, and thus should even be defined as a subspecies of Homo sapiens, while many others argue that they are a distinct species of prehistoric human correctly classified separately under the name of Homo neanderthalensis.

Regardless of which classification is correct, the research done since the Neanderthal 1's discovery has highlighted so many similarities between modern man and Neanderthals that many are now pondering upon the increasingly more pertinent question of how modern humans and Neanderthals are different rather than the previous stream of scientific inquiry that sought to unveil those few similarities shared with modern man. Little by little, as new findings are unveiled, a modern depiction of the Neanderthal is being formed, one that might instead portray a fair-skinned, red-haired body builder who skillfully hunted some of the world's most dangerous animals through sophisticated strategies that required planning, an in-depth knowledge of the landscape, and an arsenal of complex stone tools. Enduring some of the most extreme changes in weather, the Neanderthals were tough creatures who persevered through several ice ages employing their mastery of fire, and likely layering in loose-fitting clothing made of animal hide. Their proficiency with fire laid the foundation for their ability to cook, an essential human activity. Showing some of the first signs of humaneness recorded in prehistory, Neanderthals are believed to have cared for their disabled and elderly, buried their dead, and remained loyal to their small clans rather than venture off into unknown territory. Maybe most alarming of all, is the new evidence that suggests that Neanderthals held an ability for language, an ability that had previously only been assigned to modern man, and that completely transforms earlier notions of the Neanderthal as an unintelligent oaf capable of grunts, screams, and whimpers at most.

Despite their tendency to remain as homebodies, the Neanderthals once inhabited a very wide range extending from Europe all the way through to southwestern and central Asia. However, their main region of stomping grounds inhabited throughout their entire span of existence was southwestern France, Spain, Italy, and the western Mediterranean, a region with Mediterranean and sub-Mediterranean climates. The Neanderthals are known to have moved as far east as Uzbekistan (north of Afghanistan) and throughout much of the Middle East. In their final years, the last Neanderthals found refuge in the Iberian Peninsula, the region of modern-day Spain and Portugal. It is on the southern-most tip of the Iberian Peninsula in Gibraltar that evidence of Neanderthal's last known place of habitation was found, dating to between 28,000 and 24,000 B.C..

Within this wide range of land, the Neanderthals faced a large variety of environments. The most predominant habitat in the Neanderthal territory was that known as the "Mammoth Steppe" that included a wide variety of grazing mammals who fed on the abundance of grasses, and who served as a dietary staple for the Neanderthals. These mammals, along with the Neanderthals, had evolved to adapt to the fluctuating climates that characterized the time range of the Neanderthal's existence. Temperatures ranged from as warm or even warmer than today to as cold as those present at the peak of the last glacial period. The Neanderthals had to endure very long and intense ice ages that typically lasted for tens of thousands of years. It was during one of these ice ages from around 128,000 years ago to 180,000 years ago that the classic Neanderthal anatomy is said to have evolved. However, even with their cold-adapted anatomy, there is some evidence to suggest that the Neanderthals would abandon areas during periods of extreme cold to retreat to the warmer climates of the south.

The first humans with proto-Neanderthal traits are thought to have lived in Eurasia as early as 600,000-350,000 years ago. Sometime between 200,000 and 300,000 years ago, the classic Neanderthals first made their appearance, flourishing in Europe all the way up to sometime between 28,000-24,000 B.C. Comparison of the DNA of the Neanderthals and modern humans suggests that they both evolved from a common ancestor, diverging from one another sometime around 350,000 - 400,000 years ago. This led scientists to label H. heidelbergensis, a species known to be alive and widespread at the time, as the last common ancestor of Neanderthals and modern humans. However, this assertion has been largely questioned, as the fossil evidence does not appear to reflect this pattern of evolution, and rather seems to suggest that the last common ancestor of modern humans and Neanderthals may have existed even earlier in the record, possibly as far back as one million years ago. Nevertheless, a more viable candidate than H. heidelbergensis for the last common ancestor has not yet been found.

Whether the Neanderthals and modern humans parted ways in the evolutionary tree 350,000 years ago or one million years ago, the time span was long enough for notable differences to evolve between them physically and also mentally. As was already stated, the Neanderthals evolved to have what has been deemed as the "classic Neanderthal anatomy" during a very long and intense ice age. This led the Neanderthals to develop a series of physical adaptations

that made them better suited to the extreme cold. Their unique body type, relatively short and compact with short arms and legs, was ideal for retaining heat. Massively built from the ground up, Neanderthals had robust foot bones, strong and thick limb bones connected by large joint surfaces, wide hips, and a broad torso enclosing a deep barreled chest. Their radius and femur bowed slightly, normally a sign of rickets, but as with other prehistoric people was most likely a reflection of the Neanderthals' extraordinary muscularity. Laid overtop this massive and powerful skeleton was a solid layer of lean muscle that extended from toe to shoulder. Even their hands were large and far more powerful than modern humans, thought to have had a bone-crushing grip. Yet they could still grip objects precisely as modern humans, with an ability to squeeze an object between their thumb and forefinger even harder. All together, the Neanderthal body was powerfully built, adapted for exerting and resisting strong muscular force and enduring long periods of intensive use.

They were no shorter than the Homo sapiens (modern humans) of their time, but were a bit smaller in height than modern Europeans, estimated to be approximately 12-14 cm shorter than the post-WWII Europeans. The average heights for Neanderthal males and females, respectively, falls within the ranges of 164 to 168 cm (5 foot 4 inches to 5 foot 6 inches) for males and 152 to 156 cm (4 foot 11 inches to 5 foot 1 inch) for females. Their BMI's by today's standards would be rated as "corpulent." Their body weight estimated at around 76 kg (168 lbs) was considerably greater than today's estimated body weight of 58.2 kg (128 lbs) for modern humans living worldwide, and would have been greater than the weight of any other hominid of the Homo lineage. This extra body weight, however, would have been largely from their thick bones along with their high amounts of lean body mass. Overall, the Neanderthal's short stature and heavy weight would have made them out to be robust and exceptionally stocky.

To power their massive and muscular bodies, the Neanderthals are thought to have had a higher resting metabolic rate than modern humans, possibly as much as 25% higher. As this does not even take into account activity levels, adding in the Neanderthals' high activity levels results in an average total estimated daily calorie requirement of 3,000-5,500, a total that is roughly equivalent to the needs of a professional athlete during training. This would have also been sufficient enough for maintaining their body heat in the cold conditions that were often endured by the Neanderthals. To adequately meet these extreme calorie requirements, they would have had to include a lot of high-calorie foods such as meat and other sources of fat. The metabolism of such great amounts of calories requires an increased supply of oxygen. The Neanderthal body appears to have been built to maximize the uptake of oxygen with its large nasal openings and expanded chest encompassing an unusually big heart and set of lungs that together would have provided the basis for an increased uptake and flow of oxygen throughout the body, ultimately facilitating the metabolism of greater amounts of calories. With such high energy requirements for the normal maintenance of their highly active, large and heavily muscled bodies, the Neanderthals would have been limited in what energy they might expend upon reproduction. This would have likely decreased their long-term fertility rates so that they were lower than that of modern humans.

If you were to come face to face with a Neanderthal, it would be quite obvious that it was not the face of a modern human. A small chin, angled cheek bones, a robust nose with a large nasal opening, a thick brow ridge, and a face that looks as if it has been pulled forward around the nose and the upper lip would be some of the first signs that you were not looking at the face of a modern human. The jaws would be large and noticeable housing a complete row of square looking teeth. A look at their large head and you would notice how it extended higher and back farther than a modern human's with a more globelike shape to it. This round head contained a large brain that has been estimated to be 1,427 cubic centimeters, which comes out to be about 10 percent larger, on average, than the modern human brain of around 1,300 cubic centimeters. Atop their head you might find a layer of red or blond hair. Their skin would be fair in color and possibly freckled due to a lack of sun.

Living up to its reputation as a meat-eating caveman, this large brained muscle man (and woman) acquired the majority of their protein in the form of meat. Neanderthals were adept and formidable hunters who when faced with the possibility for an ample supply of meat, were willing to face some of Eurasia's largest and most dangerous herbivores present on their landscape. This is reflected in their skeletal injuries that most closely resemble those of rodeo riders who work in close contact with bulls. Without long-range projectiles, the Neanderthals were not able to keep a safe distance from such ferocious prey, but rather had to come close enough to their targeted prey in order to use their stone-tipped thrusting spears. Together their strength, fearlessness, and stone-tipped spears made them one of the top predators and most dangerous carnivores on their landscape.

While the species of targeted prey differed from one region to another, Neanderthals generally focused upon large mammals, typically favoring just one or two varieties within a given region. The most common species of prey included aurochs (the wild ancestors of domestic cattle), bison, red and fallow deer, reindeer, horses, wild goats, sheep, mammoth, and rhinoceros. Some evidence even indicates that they may have hunted cave bear, an extinct species of bear native to Europe that measured out to be comparable in size to the largest modern day bears. Contrary to the common stereotype of Neanderthals as being almost exclusive hunters of mammoth and rhinoceros, most evidence indicates that only the Neanderthals of the Ice Age plains of Northwestern Europe focused upon these dangerous beasts that no other prehistoric people is thought to have hunted. Neanderthals from different regions and time periods showed specialization in other larger herbivores such as reindeer, forest rhino, bison, horses, and aurochs.

At the lower latitudes where the climate was more temperate and smaller prey was more widely abundant, Neanderthals hunted and consumed more small and medium-sized prey in addition to the larger game typical of the Neanderthals from more northern regions. For instance, in an area that is now present-day Israel, around 80% of the faunal remains were of gazelles and fallow deer, accompanied on occasion by wild cattle, the wild boar, and the land tortoise. In another more southern locale, in a cave in Spain, the remains of rhinoceros along with red deer and rabbit were uncovered. While these diets were more diversified with the inclusion of small

and medium-sized prey, the evidence still indicates an emphasis on medium to large herbivores at these lower latitudes. Evidence of a truly varied diet replete with small game, birds, fish and shellfish is rare in the Neanderthal record. Thus, across both the southern and northern latitudes, Neanderthals were heavily reliant upon medium and large herbivores that could be supplemented with other small game, fish or shellfish as it became easily accessible.

Other prey that could simply be gathered was taken and eaten when the opportunity arose, including marine mollusks, tortoises, legless lizards, and ostrich eggs. Although, many of these items were only normally available at the lower latitudes in the more mild climates, or of course near the sea in the case of the mollusks. Coastal Neanderthals were known to collect shellfish with evidence found in areas of modern-day Italy and southern Spain. While the Neanderthals would readily gather these items that could easily be picked up, the Neanderthals are not thought to have done much scavenging in terms of acquiring meat from leftover kills.

More than scavengers or gatherers, the Neanderthals were hunters. They hunted only by foot and were limited to their main form of artillery, thrusting spears. Without horses to ride upon providing the advantages in height and speed and with none of the weaponry used by modern humans, the Neanderthals had to employ other tactics for a successful hunt. Their first tactic involved a focus upon large mammals that provided more meat to feed the whole clan. Better yet, the Neanderthals would often target an entire group of large mammals, ultimately ensuring that they got more bang for their buck. This was a feat as taking down just one of these massive and often ferocious creatures would have elicited heroic efforts.

These efforts were not undertaken on a whim, but rather were preceded by careful planning, possibly even following a scheduled year-round pattern of seasonal hunting. The Neanderthals never traveled long distances in pursuit of a hunt, most often just traveling up and down one major river valley rarely over 380 square miles in size. Due to their tendency to not venture beyond their home territory, most Neanderthals lived in the same rather small stretch of land throughout their whole life. This meant that they knew every boulder, cliff, tree and bend in the path. With knowledge of what migration paths were most commonly taken by various species every year, the Neanderthals could also find a place to hide near these paths so that they could ambush their prey when they came to pass.

They also took advantage of their extensive knowledge of the landscape to trap, injure or even kill potential prey without raising a spear. Herding their prey together and then forcing them into a frenzied stampede, the Neanderthals would cause their prey to flee right over a cliff, effectively injuring, often immobilizing, and sometimes even killing their prey. The prey would commonly be butchered on the spot, and the choicest, most energy dense cuts would be hauled to a nearby cave away from any troublesome predators looking to get in on the feast. Another strategy that employed their knowledge of the landscape involved maneuvering a herd (or part of a herd) into a steep and narrow valley in order to cut off the possibility of escape, allowing the prey to be easily killed with their thrusting spears.

Many of these hunts involved the extensive cooperation of a whole group that included women and children as well. The women and children had separate and less dangerous assigned tasks than the men, but still played their own essential roles from the beginning of the hunt to the butchering and transporting at the end. Thus, this system of communal hunting required social organization, and was likely to have involved some form of communication. At times, the hunt would focus upon acquiring prime adults that were known to have more meat, marrow, and perhaps grease than the other animals. Excess meat and marrow was likely stored in anticipation of future needs, although this cannot be determined for certain from the available evidence.

While it is clear that meat from large herbivores played a major role in the Neanderthal diet, it is not as apparent to what degree seafood contributed to the diet. Complex studies that look at the different forms of nitrogen present in the bones of Neanderthals have been used to determine both the quantity as well as the type of proteins that were being consumed. These studies involving the fossils of various Neanderthals from different regions concluded that there is no evidence of a significant contribution of marine or freshwater aquatic proteins to the Neanderthal diet. However, there is other evidence in the form of fossil remains to support the claim that Neanderthals consumed shellfish and other seafood such as fish, marine mammals (dolphins, seals, porpoises), crab, and sea urchin at least occasionally, if not seasonally. This evidence comes from sites located near the sea, suggesting that seafood consumption may have played more of a role in the diets of Neanderthals living near the coast. This was likely not an intensive exploitation of aquatic foods, but rather involved shoreline foraging that was limited by what could be easily collected. Marine mollusks was one of the many foods believed to be foraged from the shoreline. There are many sites with marine mollusks around the Mediterranean Sea stemming all the way back to the lower Paleolithic to the early Upper Paleolithic. Whether or not the Neanderthals purposefully set out to acquire mollusks and other seafood according to the season and over long periods, or whether they just consumed aquatic foods when they happened to come across them by way of luck is not known and is highly debated.

Nonetheless, seafood could have provided a welcome and maybe even important alternative to the usual Neanderthal diet laden with the meat of medium to large herbivores. At the southernmost tip of the Iberian Peninsula just below Spain, in the area of Gibraltar, the Neanderthal's last holdout before their extinction, there is perhaps the largest collection of definitive evidence for the Neanderthal's consumption of seafood. The presence of the remains of mussels, seals, dolphins, and fish indicates that many different types of seafood were being exploited there. As this was the last known place of habitation of Neanderthals before they disappeared from the archaeological record, some have theorized that it was this access to alternative foods from the sea that allowed these Neanderthals to survive for longer than their inland kin.

Another potential supplement to their diet laden in medium and large herbivores would have been plant foods. Not only would plant foods have provided a much needed dose of vital

nutrients including many essential vitamins and minerals, but they would have also helped to balance out the massive amounts of animal protein that formed a major part of the Neanderthal diet. The human body as we know it today is restricted in how much animal protein it may digest due to the liver's ability to only metabolize a limited amount of protein. Thus, over a certain amount the body won't be able to digest any more protein, with an excess in protein resulting in a cascade of negative effects that result in symptoms of lethargy, nausea and even death if this high protein diet continues without the supplementation of either a significant quantity of fat or carbohydrate. The more carbohydrates from plants or fat from fatty carcasses or plants such as nuts that is added to the diet, the more protein one can eat and not get sick. Thus, scientists presuming that the Neanderthals had the same general metabolism that modern day humans do have suggested that the incorporation of some of these foods into the diet would have been essential for the Neanderthals in order to maintain good health consuming large amounts of energy from animal protein.

For a human today, the maximum percentage of animal protein that could be safely consumed in a diet dominated by meat would be approximately 65% with the remaining 35% consisting of plant foods. This is based on the assumption that the meat consumed would also contain around 10% body fat, helping to further dilute the high protein intake. For the Neanderthals, assuming that they had a similar metabolism as we do, their diet would have likely needed to consist of less than 65% animal protein since the wild animals they had access to would have supplied less fat averaging less than 5% body fat. Thus, Neanderthals have been estimated to have reached their maximum protein intake at around 50 to 65% animal protein intake. As was previously stated, adding in more plant foods would have helped to increase the maximum amount of protein they could have safely consumed.

While plant foods certainly appear as if they would have played a vital role in diluting the heavy loads of protein present in the Neanderthal diet, the Neanderthals may have been limited in how much plant food they could have included in their diet with fewer plant resources available in their habitats. Thus, including plants in their diet may have been a much more challenging and possibly laborious task than it was for their distant ancestors of the tropical and subtropical regions of Africa.

The plant foods available to the Neanderthals in northwest Europe and throughout Eurasia would not have compared to the extensive crop of edible fruits, roots, nuts, and edible leaves that were widely available in Africa's tropical and subtropical regions. The Neanderthals would have been especially restricted in potential plant foods during the many Ice Ages that they had to endure throughout their existence. Nevertheless, even during these cold cycles, calorie-dense plant foods such as grass seeds and cattails would have been available. Furthermore, the Neanderthals living in northern Eurasia are thought to have been in an environment that supported more vegetation than is found in the Arctic and subarctic today, likely supplying them with sufficient edible food plants to balance out their protein consumption.

Of course, not all Neanderthals lived in such extreme conditions. Many Neanderthals inhabited regions in today's Middle East with much more moderate Mediterranean climates that would have had far more edible plants to choose from than in northern Eurasia. Not surprisingly, these regions have turned up the most evidence for the Neanderthal's use of plant foods. One of the most direct pieces of evidence that definitively confirms that the Neanderthals consumed an omnivorous diet including plant foods came in the form of fecal remains acquired from a Neanderthal site in southern Spain. These 50,000 year old remains, the oldest known remnants of human waste recovered thus far, were analyzed to determine the presence of both animal-derived cholesterol indicating meat consumption, and phytosterol, a cholesterol-like compound present in plants that would signal the intake of plant foods. The results showed that the fecal remains contained both animal derived cholesterol and the cholesterol-like compound from plants, providing sure proof that the Neanderthals living in this area of southern Spain were eating both meat and vegetables.

In a cave in Israel, scientists found evidence of plant food remains in the form of seeds, fruits, and tubers. This cave also unveiled a massive collection of charred plant remains including more than 4,000 charred seeds, of which 75% were legumes (mostly peas), along with a significant number of pistachios and a few acorns. Another cave in Israel unearthed evidence that suggests that the Neanderthals frequenting the cave were gathering grass seeds as part of their diet. Considering that traditionally, grass-seed consumption and cereal-based diets have only been associated with modern Homo sapiens, this evidence begins to paint a much different picture in which our Neanderthal cousins were consumers of grain as well. However, thus far, scientists are hesitant to argue that these Neanderthals intensively gathered grains, but rather, tend to side with the more tentative conclusion that they were likely experimenting with the grass family, perhaps gathering and consuming it as the opportunity arose. More recent evidence of grass seed starches in the calculus of Neanderthal teeth from another cave in Iraq added further confirmation that the Neanderthals living in the Near East consumed grass seeds (i.e. grains). The starches of grass seeds that were found most closely resemble those of barley.

Whether it be from grains, tubers, or legumes such as peas, there is evidence that the Neanderthals inhabiting today's Middle East were consuming starchy plants. Residues of starchy plants found on Neanderthal tools and particles of starch obtained directly from Neanderthal dental calculus, both provide more evidence that these Neanderthals were consuming plants that contained starch. To add on further evidence, scientists have even found plaque on the remains of molar teeth that contain particles of starch.

Within the fossilized plant remains present in the teeth of Neanderthals from the Shanidar Cave in Iraq were remnants of the fruits of the date palm, the sweet and sugary fruit that is often sold dried and that has been integral to the human diet in this region of the world for as long as history has been recorded. Compounds from yarrow and chamomile, two plants with little nutritional value but that have long been known for their medicinal properties, were also found in the dental calculus of a young Neanderthal from a site in northern Spain. Both of these plants

are bitter tasting, which is often a signal to animals of a potential toxin. Since it is known that the Neanderthals at this site in Spain contained the bitter taste perception gene allowing them to taste the bitterness in these plants that would have signaled the need to take caution with the consumption of such plants, the selection of these plants is thought to have most likely been done intentionally. If so, the Neanderthals may have been engaging in a form of self-medication. The widespread evidence for animals who perform self-medicating behavior offers further support for this proposition. After all, if all modern higher primates self-medicate, it seems quite probable that Neanderthals did as well.

The analysis of teeth from Neanderthals outside of the Mediterranean climate of today's Middle East, in the northern, oceanic environment of the Spy Cave in Belgium, revealed evidence of starch particles believed to be from underground storage organs. Underground storage organs would have served as an important carbohydrate and energy rich supplement to the meat heavy diet of the Neanderthals living in the northwestern regions of Europe. These starchy underground storage organs would have potentially been available throughout the Neanderthal range, even during the coldest periods. They would have been a particularly valuable food source during the fall and winter, times of the year in which underground storage organs store their maximum amount of energy. Together, roots, bulbs, and tubers may have formed a vital component of the northwestern European Neanderthal diet, especially during times of extreme cold when other plants would have been even less available.

Another potential plant food that may have been available in Northern Europe during the intense cold spells is the inner bark of trees. One group of scientists has gone as far as to hypothesize, based on comparisons with modern tools, that recovered mammoth ribs that have been modified were once used as bark peelers. They further hypothesized that the mammoth ribs could have also been used as digging sticks. Of course, further archaeological evidence is needed for these hypothesis to be confirmed.

The remains of plants in Neanderthal teeth has contributed significantly to our understanding of the Neanderthal diet, calling to question previous stereotypes of the Neanderthals as exclusively carnivorous creatures, and instead presenting a much more varied and omnivorous Neanderthal diet that included plants when the opportunity arose for their consumption. Beyond the role of plants in the Neanderthal diet, scientists have been able to infer other aspects of the Neanderthal diet from studying Neanderthal teeth.

First, scientists have looked at the shape and size of Neanderthal teeth. The Neanderthals' cheek teeth located on the sides and back of their mouth were much smaller than earlier peoples, coming to be roughly equal in size to those of the early, near-modern humans and modern humans. Their molar enamel was thinner than recent and other fossilized humans. Their front teeth, however, were as large or larger than those of earlier people and were particularly larger than the front teeth of modern humans. Although, these teeth would continue to shrink as the Neanderthals evolved, coming to be closer and closer in size to modern humans as time went on. Their front incisors were shovel shaped, also distinct from modern

humans. The roots themselves anchoring these front teeth were significantly larger and of a different shape than those of recent modern humans. Together, the unique shapes and large size of these teeth and their roots are thought to have enabled the Neanderthals to bite down with more gusto than the average modern human, with an added ability to sustain high and frequent loads. Such a powerful chomp is thought to have come in handy to the Neanderthals when they were using their teeth to perform other activities beyond chewing, perhaps ones that involved using their teeth as a sort of tool or third hand. Doing so would have heavily worn upon these front teeth which is indeed reflected in the extreme wear observed on many of the Neanderthals' canines and incisors. This wear was so great that it often resulted in these teeth being worn all the way down to their roots! The Neanderthal's cheek teeth have been shown to have much less wear and tear compared to their incisors and canines. This differs from modern humans whose cheek teeth and front teeth typically show about the same amount of wear. Nevertheless, the microwear present on the Neanderthals' molars indicates that they were eating similar foods as modern humans in terms of their fracture properties.

A look beyond the superficial wear apparent on the tooth's surface to the microscopic scratches, markings, and indentations of the Neanderthals' front teeth has lead scientists to further support the theory that Neanderthals commonly used their front teeth as tools. Some have even gone as far as to suggest that these scratches give clues to the Neanderthals' table manners. Making comparisons to modern human populations such as the Inuit, the markings and scratches found on Neanderthal teeth resemble those that typically coincide with a particular way of eating dubbed the "stuff-and-cut" method. This method, observed among modern day meat eaters, involves holding a large portion of meat in their teeth as they use a knife to cut bite-size portions off at their lips, the knives imparting scratches as they rub against the teeth. This way of eating has been observed among indigenous groups including the Alaskan Eskimos and Canadian and Greenland Inuits. Of course, these scratches could also be from using their front teeth as tools as has already been suggested from the unique shape and size of these teeth that would have been readily able to clamp down with force.

Other grooves observed more in spaces in between the teeth on the side and back of the mouth illuminated yet another possible Neanderthal behavior still performed by modern humans today. These grooves reflect the use of a toothpick or some form of a dental probe that may have been used to dislodge food and/or to alleviate gum pain. Another set of separate grooves found primarily on the molars may indicate the consumption of hard plant foods such as underground storage organs. And yet, other microwear patterns resemble those of some of the most carnivorous humans such as the Inuits, and not those of people who have more generalized diets. As research accumulates, a clearer picture will be unveiled that will help to further define the Neanderthal diet as more carnivorous (primarily meat) or omnivorous (including meat and plants) in nature.

Insight into the Neanderthal diet may also be gained from analyzing the chemical composition of their teeth. Different plants contain different forms of carbon depending upon their way of generating energy (in the form of carbon) via photosynthesis. When an animal or human

consumes these plants, they incorporate these forms of carbon into their own tissues, reflecting the types of plants they most commonly eat. Furthermore, predators will reflect the types of plants their prey consumes, also integrating the specific forms of carbon into their own body's makeup. In Africa, carbon is synthesized in plants to what is referred to as C3 and C4 (Carbon-3 and Carbon-4) forms. In the Northern hemisphere in Europe, however, where the Neanderthals mainly roamed, only C3 plants are found. This puts limits on what scientists may ascertain from studying these forms of carbon.

Nevertheless, scientists have been able to analyze the bones of animals present in the Neanderthal time range to determine what forms of prey were most commonly consumed by Neanderthals and whether the carbons found in Neanderthal bones are similar to other carnivores suggesting that they ate the same animals. These studies have been extremely limited, but from the few that have been performed, it has been determined that Neanderthals at one site in France had carbon compositions most closely resembling that of the brown bear. This may suggest that these Neanderthals consumed a diet similar to the omnivorous diet of these bears who were known to consume a varied diet of meat and plants. The same study also suggested that red deer and horses were commonly preyed upon by the Neanderthals living in and around today's Rhone Valley in France. More research is needed using these technologically complex methods in order to come to more pertinent conclusions regarding the Neanderthal diet.

Through the analysis of Neanderthal teeth, scientists were also able to acquire concrete evidence that Neanderthals were frequently cooking their food. Employing their mastery of fire, the Neanderthals cooked many of their plants both in Northwestern Europe and the Middle Eastern regions. As already mentioned, charred remains of edible plants have been found in a cave in Israel including cooked seeds, many of which were legumes such as peas, along with pistachios and some acorns. In Gibraltar, at the southern tip of Spain and the Iberian Peninsula, charred remains of wild olives and stone pine nut have also been recovered. While all of these charred remains were likely roasted, particles of cooked starch grains from the teeth of Neanderthals from modern-day Iraq most closely resembled cooked grains that had been boiled or baked, rather than roasting with dry heat to parch or pop the grains. Other evidence of cooked carbohydrates was found in the dental calculus of two adult Neanderthals from a site in Spain. Embedded within their teeth were roasted and cracked starch granules in addition to various chemicals known to be present as a result of exposure to wood smoked foods. By cooking their plant foods, Neanderthals may have benefited from their increased digestibility that would have enabled them to extract greater amounts of energy from these foods.

While plant remains have not been as prominent in the evidence available at Neanderthal sites, it is important to keep in mind that this may very well be due to the fact that plants rarely preserve well, especially in comparison to the bones that signify meat consumption. It was this abundance of animal bones and lack of evidence for plants that contributed to the perspective that Neanderthals ate a diet highly composed of meat. While there is no doubt that Neanderthals consumed large quantities of meat, the evidence above helps to show that

Neanderthals exploited a wide range of plant foods available in their local environments, often processing them into more digestible forms by cooking them.

While some commonly assert that the evidence of plant utilization by the Neanderthals found thus far both in the Middle East and in Europe is nowhere near to as extensive as the evidence for plant use and consumption is for the modern humans living on the same lands after 20,000 years ago, a recent study published in April 2014 contests by way of microremains (starch grains and other fossilized plant remains) in dental calculus and on stone tools that modern humans and Neanderthals consumed a similar wide array of plant foods including underground storage organs and grass seeds. This study also revealed that the level of stone technology or geographic region inhabited by the Neanderthals did not have a strong influence upon the number of plant species consumed. Thus, according to this new study, Neanderthals from Europe through Asia were consuming plants to a degree that rivaled their modern human cousins.

Nevertheless, Neanderthals might not have been spending as much time processing their plant foods before consuming them as modern humans would devote to such activities later on. Indeed, Neanderthal sites have not turned up any evidence of the intensive exploitation of plant foods that might include such things as stone artifacts for grinding or storage that are seen later in the Upper Paleolithic, Epipaleolithic, and Natufian preagricultural groups of modern humans. However, some level of plant preparation would have been required in order to consume several of the plants that have been unearthed from the Neanderthal sites. Grass seeds would have required husking, other hard seeds of legumes such as peas also would have required some form of external processing in the form of germination, milling or cooking, and underground storage organs would have required harvesting. As was already stated, it is clear from the many charred plant remains that the Neanderthals were frequently cooking their plants, which would have ultimately helped to increase their digestibility and overall energy content.

Of course, the Neanderthals also cooked the many animal foods they consumed, increasing their digestibility and energy content as well. Obtaining and processing certain parts of the animal required knowledge and skill. Based upon the skeletal remains of their kills, the Neanderthals appear to have commonly performed systematic and routinized processing of game. A close analysis of the cuts and breaks on numerous skeletons revealed a continuity in the procedures used to butcher each carcass. With communal hunts that led to massive killings, the carcasses were subjected to standardized treatments that included the selective rejection of certain parts at the site of butchering. In order to obtain the marrow within the long bones, the Neanderthals employed a technique in which they first removed one end of a long bone, and then popped off the front surface of the bone to reveal the intact marrow cavity. Before this much effort was exerted, they would sort the limb bones according to the suspected quality of the marrow. Young and sub-adults known to have marrow that was not as rich were selected against and discarded, while adult long bones were preferred. In the end, only the richest elements of marrow and grease were kept.

Once they obtained the most fat filled bones, it does not appear that they used hot rocks in water to further draw out the grease from the bone. This practice of using boiling water to draw out the extra fat from the bones is known as grease rendering and was a widespread practice among modern humans. A common sign in the archaeological record that indicates stone-boiling and thus grease rendering is the presence of fire-cracked rock. However, no fire-cracked rock is found that dates back to the time of the Neanderthals. At two sites in France, the long bone epiphyses (ends of the bones richest in marrow) were absent relative to the shafts of the long bones, leading scientists to suggest that the ends were missing due to their use for bone grease rendering. While this hypothesis appears to be supported from the evidence obtained, there is still a complete lack of evidence from other Neanderthal sites of such activities. All together, there is very little evidence for advanced fat-rendering techniques among Neanderthals. Lacking a hot-rock technology for obtaining extra fat from bones and considering the major need for fat in their diet to balance out their high protein intake, one scientist has proposed the hypothesis that the Neanderthals crushed the marrow rich ends of bones into a 'bony paste' that could be swallowed. Perhaps this bony paste could have even been stored in the same way that the bone grease obtained through boiling was by modern humans. However, there have not yet been any reported storage containers for meat and fat thought to have been used by the Neanderthals. There is also a total lack of direct evidence during the European Middle Paleolithic for common meat preservation techniques such as smoking, drying, salting, and mixing with other natural preservatives such as berries rich in organic acids.

Without meat preservation, the use of storage containers for meat and fat, and the techniques for rendering that extra fat, the Neanderthals would have been at a great disadvantage. Assuming the Neanderthals did not have these capabilities, they would have been unable to acquire as many calories as modern humans were living in the same environments. Some scientists believe that it was this inability to acquire as many calories that may have resulted in the Neanderthals being outcompeted by modern humans, ultimately leading to their supposed extinction. This point of view is also supported by any evidence that suggests that Neanderthals had a restricted diet focused primarily on large animals and lacking in many other foods eaten by modern humans including marine resources, small and hard to catch animals, and the huge diversity of plant foods commonly seen in modern human diets.

However, as has already been touched upon in this summary, there is a growing body of evidence that tells a very different story, one in which Neanderthals included an array of plant foods and perhaps even marine resources in their diet. Other evidence has suggested that there are no significant differences in the choice of prey between Neanderthals and the modern humans of the time, nor is there with the hunting and butchering behavior between the two. As expected, this contradicting evidence has led to widespread controversy on whether or not it was the Neanderthal's lack of dietary breadth that played a role in their extinction. Ultimately, more evidence is needed before any definitive conclusions can be made.

Nevertheless, it is important to keep in mind that if modern humans did indeed outcompete the Neanderthals by way of dietary diversity, Neanderthals did not go extinct overnight. In fact, modern humans and Neanderthals shared the same part of the world for twenty-five thousand years, nearly three times longer than we have been recording our own history! In this time, Neanderthals and modern humans would have undoubtedly came face to face. This idea is fully supported by the fact that most modern human DNA contains Neanderthal genes. It is also supported by the discovery of the bones of a modern human and a Neanderthal child lying together, a scene that sadly took on the disturbing conclusion that this was evidence of not a loving embrace, but rather of an hunger-induced embrace. The researchers on the scene made the conclusion that the Neanderthal child was made a meal of, and that this was a case of cannibalism, a gruesome conclusion that cannot be fully verified.

While the evidence is not so clear on whether or not cannibalism had a place regarding the relationship between Neanderthals and modern humans, we do know for certain that they were making love. As mentioned, most modern humans have Neanderthal genes. More specifically, it has been estimated that 1 to 4 percent of the genes present in the genetic code of modern Asians and Europeans has a Neanderthal origin. This finding confirmed previous suspicions that Neanderthals and modern humans interbred. Since both Europeans and Asians contain Neanderthal genes, this gene flow likely took place before modern humans expanded into Europe and East Asia. Modern indigenous Africans, on the other hand, were found to have no Neanderthal genes in their genome, likely reflecting that the interbreeding took place after modern humans had migrated out of Africa. Scientists have estimated that this period of love making between the two groups took place in between 40,000 to 80,000 years ago. This came after they had been split hundreds of thousands of years back, some 500,000 years ago, from a common ancestor that probably had lived in Africa. In terms of evolution, this split did not leave too much time for the genomes to evolve and change. Thus, when they did eventually cross paths, the Neanderthals would have still been quite close genetically to modern humans. Scientists have estimated that the Neanderthal and modern human genomes are 99.84% identical, thus differing by only a fraction of a percent, a mere difference of 0.12%. While this sounds like an extremely small variation, this still is thought to have been enough to make the prospect of mating and producing healthy and fertile offspring a feat that pushes the edge of normal biological capabilities. That is to say that while this interbreeding was a viable endeavor, it likely pushed nature's bounds so that the resulting hybrid offspring probably suffered from significant fertility problems. In spite of these challenges some of these offspring survived and bore children that spread the Neanderthal genes that are now widely found in Asians and Europeans living today.

Different people have different Neanderthal genes. Remarkably, these genes still exert their effects, some of which are positive and others of which are negative. Some of these fragments of Neanderthal DNA found in modern humans today have been associated with genes that affect diseases such as Crohn's disease, lupus, biliary cirrhosis, and type 2 diabetes. Aside from these negative effects, Neanderthal DNA in the human genome has provided benefits as well. Neanderthal DNA supplied genes that code for tougher skin, hair, and nails that would

have been beneficial in the colder environments encountered in Europe and Asia. Neanderthal DNA may also have lent modern humans the gene that codes for lighter skin pigmentation, another characteristic that would have been adaptive in the new environments that had limited sunlight compared to Africa. Light skin is better at soaking up vitamin D from the sun than dark skin, and thus would have been of great benefit to the modern humans trying to adapt to the new climates in Europe and Asia.

The identification and analysis of Neanderthal DNA's place within the modern human genome would not have been possible without the many Neanderthal fossils that have been discovered. Just recently, in December 2013, scientists reported for the first time the entire Neanderthal genome that had been extracted from a toe bone of a 130,000 year old Neanderthal found in a Siberian cave. This fossil and others have served as the raw material for harvesting Neanderthal DNA.

As was stated in the intro, the first fossils ever discovered of Neanderthals were actually not even regarded as belonging to a separate archaic species, but were instead thought to have been the skeletons of modern humans who had suffered from a disease associated severe deformities. These initial fossils were uncovered as far back as the early 19th century with discoveries made in 1829 at Engis, Belgium, 1848 at Forbes Quarry, Gibraltar, and a discovery in 1856 in the Neander Valley in Germany. It was this last discovery made in August of 1856 that finally sparked the interest of the scientific community resulting in the conclusion that these were not just the bones of a strange looking modern human, but instead were the fossils of an ancient human form distinct from the modern human. Dubbed the "Neandertal Man" after the valley in which it was found, this fossil would go down in history as the first officially recognized fossilized human form, although the prior two discoveries made in 1829 and 1848 would later be acknowledged as the first early human fossils ever to be found.

The unearthing of subsequent fossils would follow, adding further support to the belief that these were not just the bones of malformed modern humans. The first relatively complete skeleton was found in La Chapelle-aux-Saints, France in the year 1908. The skeleton was of a man who was at least 40 years old, which would have been elderly by Neanderthal standards. The reconstruction of this skeleton resulted in the specimen having a slouched posture and bowed legs. This led the scientist working on the fossil to claim that the Neanderthals were more ape-like in appearance, hunched over and with a shuffling gait. Such a description led to the common portrayal of the Neanderthal as a brutish and dim-witted caveman who resembled a species that was half-man and half-ape. It was not until much later - in the 1950's - that this reconstruction would be questioned and it would be determined that the skeleton's hunched over posture was the result of a severe case of degenerative joint disease that had affected the spine, and the bowing of the legs was likely from enduring rickets disease in childhood or simply a reflection of the Neanderthal’s extreme muscularity that could have caused the legs to bow as well.

To top off the most complete Neanderthal skeleton yet to be discovered, another cave in France turned up the largest and most complete Neanderthal skull ever to be found labeled "La Ferrassie 1." Discovered just one year after the skeleton was, in the year 1909, the skull was found with several other Neanderthal fossils at La Ferrassie Cave. All together, the fossils were comprised of a total of eight individuals including adults, children, infants, and two fetuses. Both males and females were represented giving scientists their first glimpse into the variations that were present between the two sexes. Most importantly, the skeleton that paired with the complete skull found in this cave included a leg and foot bones that upon analysis confirmed that the Neanderthals walked fully upright with a gait similar to modern humans, and that the slouched posture of the old man of La Chapelle had indeed been an exception, and was not the norm.

Another fossil found in Shanidar, Iraq gave insight into more than Neanderthal anatomy. The fossil known formally as Shanidar 1 and nicknamed Nandy was that of an older Neanderthal who lived until 35-45 years of age. His skull revealed that he had suffered a crushing blow to his head at a young age that damaged his left eye socket, possibly blinding him, and the area of the brain that controlled the right side of his body likely leaving him with a crippled right arm and leg. With such disfigurement, scientists concluded that Nandy would not have been able to survive without the care of his social group, suggesting that the Neanderthals were caretakers who supported those in their group who would not be able to survive on their own.

One of the surprising findings from the skulls found was that the Neanderthal brain cases were as large as those of modern humans. In fact, in many cases they were larger! However, when the Neanderthals' large body size was accounted for, this difference was shown to be less significant than originally thought. Nevertheless, the difference that is present may simply reflect another adaptation to the cold as larger brains are more metabolically efficient in cold climates. It may also be related to their large amount of lean body mass. In support of these theories, among present day modern humans, the largest average brain size that is roughly equal to or even larger than the Neanderthals' occurs in the Inuit who live in cold climates and have large amounts of lean body mass.

The large size of the Neanderthal brain does imply that they were more intelligent than their smaller brained predecessors. Of course, similarity in size does not directly imply closeness in structure, organization of brain cells, or mental abilities. The Neanderthal brain was somewhat different in shape and proportions from the brains of modern humans, and yet thus far there has been no significant evidence to support the claim that Neanderthal brains functioned differently than that of modern humans. Even so, some scientists have still tried to draw links between the varying shapes and volumes of the Neanderthal brain and specific abilities or inabilities compared to modern humans. For instance, the presence of one enlarged area of the Neanderthal brain typically associated with visual abilities has been interpreted as a potential indicator that the Neanderthals possessed enhanced visual and spatial capabilities. Of course, this interpretation is mainly speculative at this point.

Another key question to be answered in order to gain a more clear understanding of Neanderthal life and how it may have been similar to and different from that of modern humans is the issue of whether or not Neanderthals possessed an ability for language. Unfortunately, nothing definitive can be determined from what we know about the shape and size of the Neanderthal brain. The shape of the skulls encasing their brains indicate that they had an expanded Broca's area, a region that is enlarged in modern humans compared to other primates and that is known to be involved in speech production. However, no conclusions can be drawn from this since this area of the brain has also been associated with tool use, making it impossible to know whether the expansion in this area of the Neanderthal brain is the result of their extensive use of tools or reflects their use of language. Looking at the anatomical evidence beyond the brain, there is one bone that forms a part of the vocal tract that has been preserved in the Neanderthal fossil record. This bone, the hyoid bone, is the only bone in the vocal tract where it plays a central role supporting the larynx and acting as an anchor for the tongue and many other muscles involved in speech. Using computer generated models, scientists were able to analyze the movements and functions of this bone in the Neanderthal vocal tract taking into account the bone's unique internal structure. Analyzing the mechanical behavior from these models, the researchers concluded that the Neanderthals used their hyoid bones in the same basic way as humans, supporting the idea that Neanderthals held an ability for speaking.

Another finding that acts as further evidence that the Neanderthals did indeed possess an ability for language was recovered from a fossil found in a cave in northern Spain. The DNA that was harvested from this Neanderthal revealed that Neanderthals shared the unique human form of the FOXP2 gene that has been proven to be key to speech development and is thought to have been selected for as an adaptation to the use of language. While this does not prove that Neanderthals had fully developed a capacity for speaking akin to modern humans, it does provide a provocative piece of evidence that they were talking apes.

If Neanderthals did have an ability to speak, did their speech sound similar to that of modern humans? Or, more importantly, did Neanderthals have what it takes to successfully sing out Michael Jackson's song "Billie Jean" on karaoke night? The preponderance of evidence suggests that they would be told to pass on the microphone and sit back down. The sounds generated in speech are largely dependent upon the angle (or lack of angle) of the skull's base along with the position of the larynx, also known as the voice box that encases the vocal cords. Modern humans have much more angled skull bases and voice boxes that sit lower in the throat than chimpanzees. These two characteristics are thought to have evolved to enable modern humans to speak as they do. Neanderthals had skulls with an angle intermediate between that of chimpanzees and modern humans and a larynx positioned higher in their throat than modern humans, suggesting that they may have been unable to generate the full range of vowel and consonant sounds that modern humans can.

Nevertheless, regardless of whether or not the Neanderthals possessed a subhuman ability for language as their caveman stereotype might suggest, the current evidence taken together

makes a strong case for the Neanderthals' capacity to speak. Put into the context of what we already know about Neanderthals, an ability to communicate would have been a critical tool for effective hunting to the degree practiced by Neanderthals. In fact, the scale of hunting performed by Neanderthals would have almost necessitated communication as a way to coordinate actions of a group of hunters quickly. Speech may have also been helpful in avoiding predators by allowing individuals to spread the word on the presence of potential predators. Beyond these uses of language that involve communicating a situation directly at hand, there is nothing in the record to suggest that Neanderthals were creating elaborate stories or myths as modern humans were. Neanderthals don't appear to have used fire in the same social way, gathering around it for a night of story telling. The evidence also implies that they were homebodies who rarely interacted with neighboring communities, and thus had no reason to develop their language to interact with strangers. This stands in stark contrast to modern humans who were willing to base part of their livelihoods on communication and trade with neighboring territories.

Trade might have helped to foster and spread innovation, something Neanderthals largely lacked. In modern day terms, Neanderthal behavior might be described as neophobic, dogmatic, and xenophobic. Neanderthals are thought to have been inflexible, acting according to a rigid way of doing things and showing fear or a general dislike for things that were new, foreign, or seemingly strange. Such behavior certainly did not lay the foundation for ingenuity. In the entire 200,000 years of Neanderthal existence, there was very little achieved in terms of technological progress. The tools they did make, however, were carefully crafted, sophisticated stone tools that were made according to the methods that had been passed along from generation to generation. The cultural complex that encompasses the Neanderthal way of making tools is known as the Mousterian. The Mousterian is a flake-based industry that employed techniques for pre-shaping the flake (i.e. future tool) before it was struck from the core of the material from which it was made. The Mousterian toolset included various types of side-scrapers, hand axes, points, notches, denticulates with their notched edges, and flake-blades. Most of the tools were used to work various materials including wood, bone, hides, and meat. Tools were generally composed of stone with few skillfully shaped bone tools. Sophisticated bone technology is not seen in the Neanderthal timeline until towards the end of their existence in the Initial Upper Paleolithic that began around 50,000 years ago. Wood was likely used for making tools far more commonly than bone, but since wood does not preserve well, there is no evidence to support for certain a widespread use of wooden tools.

The only clear example of Neanderthal innovation lies in the construction of spears made of a stone point that was hafted onto a wooden shaft, an invention that supposedly appeared around 200,000 years ago. The Neanderthals are thought to have invented hafting, using different types of glue-like substances to stick the stone point to the top of the shaft. At a site in Syria, scientists found a point whose base was covered in bitumen, a kind of natural asphalt. In Western Europe, Neanderthals used pitch made from birch bark. Still, others may have tried tying the point onto the shaft, although this of course cannot be determined from the archaeological record. The stone point on top was a flat, triangular-shaped stone tool that was

sharp along two edges. This point, formally referred to as the "Levallois point," was effective but also quite technical to make. Together, these spears with their stone Levallois points and wooden bases were vital to the Neanderthals' existence as they provided an effective weapon for hunting large animals.

Their weapons and tools were so effective that they rarely ever changed them. As was already mentioned, the Neanderthal toolbox is unique for its almost complete absence of innovation, in stark contrast to modern human's affinity for constant innovation to the point in which it has become known as a basic part of human nature. This may be one of the most essential differences between the Neanderthal mind and the modern human's. That is not to say that the Neanderthals never made adjustments to their tools or techniques. They most certainly did, tweaking here and there, and making changes to established methods when the need arose to do so. They were flexible enough to vary their knapping (i.e. shaping) techniques according to the nature of the raw materials at hand. However, they were not actively inventing. Given their perceived intelligence based upon their ability to survive in such harsh environments hunting large and ferocious beasts such as the wooly mammoth for around 200,000 years, one would think they would have exercised more novelty and originality with their toolset.

Even if they were not active innovators, the Neanderthals were adept at taming the flame, using fire often and effectively. They knew how to make it by way of friction or by creating sparks using iron to strike flint. They also knew how to maintain it. Fire offered them warmth against the bitter cold of glacial Europe and could also be used for transforming their food into more digestible forms through cooking. Cooking was particularly essential for making meat more suited to the human body that is not designed for the efficient digestion of large sums of uncooked meat as are the teeth and digestive tracts of carnivores. Cooking meat made it into a high quality food, one in which the Neanderthals could depend upon when plants were scarce due to conditions of extreme cold.

Beyond providing food and warmth, fire was also depended upon by the Neanderthals for crafting their tools and weapons. Fire was needed to form the pitch (i.e. a glue-like substance) from birch bark that, as was already mentioned, was applied to the base of stone points in order to stick them onto wooden shafts, ultimately producing a large spear. Other natural materials such as asphalt could be heat-treated and then used for hafting stone tools as well. Fire may have also been used to alter stone into more malleable forms that could be more easily shaped into tools.

Many Neanderthal sites have evidence of well-defined hearths, often recurring in the same place over long periods of time. There are a few stone-lined or stone-delimited fireplaces that have been dated back to the time of the Neanderthals, but they do not appear to be nearly as common as later on around the time of the modern humans' arrival into Europe. In addition to wood, bone may have also served as a source of fuel for their fires.

Neanderthals are not thought to be the first of our ancestral lineage to have used fire. While it is highly debated, the first widely accepted definitive evidence of the controlled and habitual use of fire in Europe comes from the period around 300,000 to 400,000 years ago. This is much later than other early hominins are thought to have migrated into Europe, thus suggesting that early hominins originally moved into northern latitudes without the habitual use of fire. Of course, this does not preclude the occasional and opportunistic use of fire in earlier times, a possibility that is still being explored by many scientists.

Nevertheless, looking at the evidence dating from 300,000 years onward, the number of sites with good evidence of fire increases, leading scientists to conclude that Neanderthals had fire management skills not unlike that of the modern humans who migrated up into Europe much later on. However, while both Neanderthals and modern humans may have managed fire similarly, they may have used fire differently, at least in one fundamental way that may reveal a major distinction between Neanderthals and modern humans. When modern humans gathered around their fires they did much more than cook food and warm themselves. For at least the last 25,000 years, modern humans have been gathering about the fire to talk, recite myths, and perform rituals which together sprouted the formation of a spiritual life. Unlike modern humans, Neanderthals never used fire in this way, reserving its use for warmth, cooking, and tool making only. It has been suggested that Neanderthals lacked a symbolic ritual life, not having any kind of narrative tradition. While a lack of storytelling may seem minor, such a distinction may act as a clue to why we are still here while the Neanderthals are extinct. The storytelling and spirituality of modern humans is reflective of our creativity, something which the Neanderthals may have lacked, which would have prevented them from innovating and adapting, as their static set of tools also indicates.

Besides fire, the Neanderthals would have needed shelters and some sort of clothing to stay warm. Despite their caveman stereotype, Neanderthals were not pure cave dwellers. Indeed, they used caves and rock shelters when they were available, adding on a kind of tent at the entrance for extra protection. However, in the open environments there were no caves, leading some Neanderthals to build their own dwellings with mammoth tusks and bones that were probably draped with tanned hides to form tent like shelters. Neanderthals are accredited as the first early humans to wear clothing. In subfreezing temperatures away from a fire or shelter, their clothing might have had to come somewhere close to the insulation value of a modern day business suit in order for them to survive. With no evidence of bone needles and other artifacts that mark the creation of more tailored clothing seen with the modern humans later on, it is assumed that the Neanderthals' clothing was loose-fitting. While the clothing may have been made from hides, there is no evidence to indicate that the Neanderthals had employed smoking or other techniques integral to more advanced forms of hide processing. Nevertheless, the Neanderthals did have scrapers that they could have used to clean the animal hide, and they also had awls, large stone or bone versions of the modern day sewing needle, that may have been poked through the hide to lace together a loose-fitting clothing item. Tighter fitting clothing would not come until later, sometime around 50,000 years ago with modern humans who used smaller bone sewing needles to sew their clothing together tightly in a more tailored fashion.

50,000 years ago was around the same time that human body lice evolved, adding further support that this was the time in which more modern day clothing was invented.

Footwear may have been invented and used even later on, possibly around 28,000 years ago. Modern humans and Neanderthals are thought to have gone barefoot or worn light footwear only occasionally before then, a conclusion that calls to question how the Neanderthals would have endured the ice, snow, and utter cold beneath their feet for so long. This is one of the many mysteries yet to be uncovered about the Neanderthals. Another unsolved mystery is how tools resembling those of Neanderthals as well as other remains corresponding to the time of the Neanderthals made their way onto many of the Greek islands. Since the distance to these islands through the sea would have been basically impossible to swim, some scientists have theorized that the Neanderthals were seafarers who made their way to these Greek islands from the Greek mainland by way of boat. Such a theory of course implies that Neanderthals had the technology and intelligence to construct a floating vessel of some sort and to successfully navigate it through the sea. This strongly goes against previous theories that designated seafaring as a more advanced activity that only arose with modern humans. Since wooden boats don't stand the test of time, no direct evidence to definitively support the idea that Neanderthals were indeed mariners can easily be found. Thus, how these Neanderthal tools made their way onto these islands remains a mystery.

Our knowledge of Neanderthal society is less mysterious and more straightforward. The Neanderthals lived in small communities of fewer than a hundred individuals that may have included ten to twenty families related through the male or female line, and possibly as few as 12 or 25 people in smaller groups. Neanderthal families are thought to have consisted of a pair-bonded man and woman, their children, and perhaps, if they were lucky, a surviving older relative. The family was the primary foraging unit with all members participating.

All members regardless of age or sex performed tasks using their front teeth as their third hand as is still done in some hunter-gatherer populations today. The Neanderthals used their teeth extensively in activities unrelated to eating such as for tool production, the preparation of furs and also of food. Variations between the dental grooves and nicks on the teeth of Neanderthal men versus Neanderthal women suggests that Neanderthals divided some of their tasks according to sex, although scientists have not been able to yet determine what specific tasks were performed by each sex. Nevertheless, these findings do suggest the presence of a sexual division of labor in Neanderthal society, a significant finding since sexual division of labor was previously thought to only occur within modern Homo sapien societies. However, compared to modern hunter-gatherers, Neanderthals appear to have had less extreme sex-related specializations of labor which were probably limited to a few tasks.

Hunts, particularly for big animals, involved everyone including men, women, young and old. Neanderthals were about as sexually dimorphic as modern humans, making the Neanderthal men more powerful and better suited to killing than the women. Nevertheless, the women may have performed less dangerous tasks as evidenced by fewer severe skeletal injuries among the

adult women than with the men. Women and children are not thought to have taken part in the in-close killing, but may have helped drive or distract game and possibly aid in the butchering and transport of meat back home. The hunts also required the participation of several families that would come together to achieve a big kill from which all would reap the benefits. Beyond these hunts, members of a community remained in close--often face-to-face--contact. As was previously mentioned, this direct contact was rarely made with neighboring communities. Such contact would have been difficult even if efforts were made to interact since Neanderthal communities were known to be thinly spread across the landscape.

The overall estimated population size of Neanderthals worldwide never reached into six figures. Genetic information obtained from Neanderthal bones indicates that the total population of adult Neanderthals reached at most seventy thousand, probably dwindling to around ten thousand in the last forty thousand years of their existence. Comparing these numbers to the modern humans who eventually invaded their territory, the Neanderthals appear to have been much smaller in number. The question as to why they were not as numerous is harder to answer. Some have proposed that it was their extremely high calories needs compared to the smaller and leaner modern humans that limited the amount of people they could keep fed. Furthermore, it has been suggested that the Neanderthals were less efficient at obtaining their calories from both animal and plant resources due to their lack of technology that would have enabled them to extract more calories from their foods. Combined with their higher calorie needs, this might have further limited the population size.

Within their small clans there was a small number of older adults. It has been estimated that only about one-third of the adult Neanderthals were older when they died, whereas around two-thirds of the modern humans living later on around 20,000 years ago were from the older age range. With fewer older adults around, adult knowledge, experience, and labor were in short supply, putting limits on what knowledge, skills and insight the younger generation might acquire from their elders. To add to the matter, many adults died at a young age, leaving behind young children who were then forced into adulthood very quickly in the name of survival. These children had to forsake their childhood, the period in which they were to develop their creativity that would later help spur their ability to successfully solve complex problems. In the long run, without proper time to develop and with very few older adults to learn from, the Neanderthals faced a major barrier to expanding and adapting, having to go by what they already knew rather than getting the opportunity to experiment and innovate. Such limitations might be part of the reason why we are still here and why Neanderthals eventually perished.

Also reflecting this lack of creativity is the virtual absence of art or ornamentation left behind by the Neanderthals. Artistic or symbolic objects believed to be associated with the Neanderthals are very few in number and unimpressive in appearance, especially as compared to that left behind by the modern humans later on. Nonetheless, scientists have uncovered a few provocative items. Some of the most convincing objects of artistic merit in the Neanderthal record may be grooved and pierced bones and teeth found at sites in France, Belgium, and the Ukraine that may represent a type of primitive jewelry used for ornamental purposes.

Perforated marine shells from two sites in Spain may have also been used as pendants. Other bones and pieces of stone bear intentionally made markings with no known functional purpose. A round river cobble with a straight crack down the center appears to have been engraved by a Neanderthal with a second line perpendicular to the first. Rock crystals found at some sites indicate that the Neanderthals may have found these little gems interesting or perhaps pleasant in appearance, enough so to swipe them up and carry them home. In line with their caveman stereotype, scientists uncovered a piece of mammoth molar shaped into an oval plate from modern-day Hungary. All of these objects mentioned certainly hint at an attraction to patterns and a concern for appearance among the Neanderthals, but in the big scheme of things these items are simply too few in number to know for certain.

Perhaps even more provocative is the discovery of the remnants of mineral pigments at Neanderthal sites. These were found at many Neanderthal sites, suggesting that the use of mineral pigments may have been much more common than the production of other artistic items already discussed. The two minerals discovered include hematite (also known as ochre) and manganese dioxide. Ochre, a mineral that imparts variations of red, yellow and orange pigments, is common in many prehistoric sites around the world. In Africa, it is believed to have been first used around 300,000 years ago during the time of Homo heidelbergensis. The evidence indicates that the Neanderthals used ochre, but more commonly made use of the black powder from manganese dioxide. Manganese dioxide with signs of Neanderthal modification and use has been found at more than 40 European Neanderthal sites. Unfortunately, how these two minerals were used is not known. Perhaps the most provocative interpretation is that manganese dioxide was used to color something, possibly even their bodies. Of course, this is just one alluring possibility that has no real evidence to support it. Despite the exploitation of minerals, there have been no depictions found in the Neanderthal record--not one. There hasn't even been anything that could possibly be interpreted as a representation of anything, animal or person.

Any evidence of ritual or religion among the Neanderthals is as scarce as the evidence found thus far of Neanderthal art. However, the discovery of Neanderthal burial sites did lead scientists to strongly consider the possibility that the Neanderthals had a religion that involved ceremonial rituals performed in conjunction with these burials. Unfortunately, there is no evidence to support such ideas. From what we currently know, the Neanderthals appear simply to have dug holes and buried bodies so that they would be out the way. Indeed, the evidence appears to indicate that they generally just took advantage of a natural depression such as the one at the rear of La Ferrassie or perhaps expanded upon a natural low spot by scraping out some of the earth, just enough so that the corpse could be positioned to fit. The corpse would then be covered with some debris and earth, and that was that. There were no grave goods in the form of artifacts or food paired with the corpses as is found throughout the modern humans' record. The corpses were treated minimally, apparently without employing any recurring techniques or placing the bodies in any standard orientation. Put simply, it seems as if the Neanderthals were just interested in hiding them in a way that was the easiest and most accessible.

Thus, if the Neanderthals did believe in life after death, they did not place importance upon the body's preservation for the afterlife. The evidence shows that the Neanderthals often lived among disturbed bones of previously hidden corpses, often shoving them to the side in the same way they moved aside animal bones. If the Neanderthals were burying their dead to help alleviate the pains of death and as a form reverence to the deceased, their attachment to the bodies appears to have been very short term. In addition, while the occurrence of elaborate rituals and ceremonies might just be invisible in the archaeological record, there is no evidence thus far to indicate that the Neanderthals engaged in large-scale rituals of any sort. There have been no signs of religious or symbolic components to make us think that their burials included a religious component. Thus, it is easy to see that Neanderthal burials are certainly not similar to the graves we come to think of that are made by modern humans today and in the past. That is not to say that the occurrence of Neanderthal burials does not mark an important stage in our evolutionary past.

All together, scientists generally agree on the presence of about 35 Neanderthal burials, taking into account both Europe and western Asia. Three forms of evidence support the conclusion that the Neanderthals buried their dead. These include the presence of burial pits at some sites, the flexed position of several Neanderthal bodies, and the state of preservation and completeness of many of the Neanderthal skeletons. Not all Neanderthal sites with human remains have evidence of burial. Nonetheless, the Neanderthals are generally recognized as the first humans to bury their dead, at least on occasion.

Beyond a simple burial, some scientists have discovered what they believe to be the remnants of a very different form of corpse treatment. From their perspective, cut marks and other signs of postmortem processing on Neanderthal bones have been interpreted as evidence that Neanderthals feasted upon their own people, engaging in the act of cannibalism. Recovered bones of six Neanderthals from a cave site in southern France bore the signs of a full butchery from head to toe. Muscles were stripped, bones were smashed, and skulls were shattered. Every part of the human remains appears to have been exploited in the same fashion that Neanderthal processed animal bones, and in a way that could not have been done by a carnivorous animal. Other bones from other sites draw up similar scenarios. An alternative explanation to cannibalism agued by some is that these bones underwent alterations involved in a secondary burial, a sort of ceremonious reburial that in the case of modern humans often involves cleaning and modifying bones in a way that can leave cut marks. Of course, from what we already know about Neanderthals, it seems unlikely that they would have engaged in such a ceremonious occasion.

Whether or not Neanderthals feasted upon their own is a highly debated topic with some arguing that there is no real evidence for such behavior and that such claims have just been made due in part to the common brutish and uncultured stereotypes that have been unjustly pinned upon the Neanderthals. Others attest that Neanderthals probably only rarely ate one another, perhaps in cases where they were driven to extreme states of hunger and were thus

forced into such behavior for the sake of survival. Whatever the case may be, if they did partake in cannibalistic feasts, they would be no different from ancient and existing modern humans who are well known to have practiced cannibalism.

Besides the potential for sharing in the act of cannibalism, the Neanderthals may have also shared patterns of increased potential lifespans and a slowed rate of development with modern humans. New research that sampled a very wide pool of Neanderthals and fossilized modern humans provides evidence derived from teeth to prove that Neanderthals had more prolonged lifespans and childhoods than their predecessors, falling in line with the evolutionary continuum towards modern humans' prolonged childhoods and lifespans. Neanderthals appear to have been evolving in the direction of the modern human pattern of slowed development, however, modern humans may represent an even greater extreme. The most recent studies do draw a line of distinction between the two, showing that the permanent teeth of the Neanderthals grew in significantly faster than modern humans. This may be further indication that Neanderthal kids reached adulthood a few years earlier than modern humans. Indeed, the Neanderthal wisdom teeth erupted earlier than those of modern humans, coming in at age 15 instead of 18 or older typical of modern humans.

Coming into adulthood a bit earlier than modern humans may have served as an advantage for Neanderthals who typically died when they were just reaching what we today consider to be just young adulthood. Around 80% of all recovered Neanderthal skeletons appear to have died as young adults so that few Neanderthals survived beyond their peak reproductive years. Most perished before reaching the age of 40 and none of the skeletons thus far have been aged to more than their mid-40s. Thus, it would have given them more time to bear children and may have also enabled them to reach a level of size and strength earlier that would have been favorable under the harsh conditions they faced. The harsh conditions of their time also probably contributed to their high infant mortality rates. Taken together, all of these factors may have acted to favor the evolution of a more rapid pattern of growth and maturation among Neanderthals.

Facing such severe conditions, the Neanderthals may have also evolved their concern for the old and sick in order to prolong their lifespans and ensure the survival of their fellow kin. There were very few, if any, adult Neanderthals that did survive that did not suffer from some form of physical handicap or disease. Perhaps the most widespread disease occurring among the adult Neanderthals was degenerative joint disease also informally known as arthritis, thought to be the result of their lives of constant and heavy physical exertion. At one site in Shanidar, Iraq, all of the adult Neanderthals suffered from arthritic joints in places all over their bodies including their knees, shoulders, elbows, ankles, feet, and back. Beyond arthritis, skeletons of older Neanderthals also commonly include healed fractures of the skull or limbs, a reflection of the dangers of living in the Paleolithic age.

Dental pathologies of any sort are considered to have been relatively rare among Pleistocene humans including the Neanderthals. Their teeth occasionally show signs of periodontal (gum)

disease, but dental caries (cavities) are very rarely seen in Neanderthal teeth with only 6 cases being reported in the 1250 Neanderthal teeth that have been recovered. The caries that have been detected come from the Neanderthal sites in the south near the Mediterranean, and may reflect the consumption of carbohydrate-rich foods (e.g. fruits & other sugar-rich plant organs) present in these regions known to contribute to the development of caries. As already mentioned previously, starch residues gleaned from the dental calculus of Neanderthals provides direct evidence that Neanderthals consumed cooked carbohydrate-rich foods. However, the much lower incidence of caries among Neanderthals as compared to semi-sedentary, agriculturally based modern humans that lived later on may possibly be indicative of a decreased dependence upon such carbohydrate-rich foods by Neanderthals. Furthermore, the prevalence of caries among Neanderthals is very low as compared to recent populations living in high-latitudes similar to Neanderthals and consuming unrefined, pre-industrial foods. Neanderthal teeth from more northerly locales and from western Eurasia have not yet shown any evidence of caries, potentially due in part to restricted access to carbohydrate-rich foods. As a whole, the teeth of Neanderthals from all regions display a level of oral health rarely observed with more recent, sedentary human populations that don't have access to routine dental care.

Analysis of Neanderthal teeth also revealed the common occurrence of periodic food shortages. Pits and grooves found in the enamel of the teeth showed that almost 40% of Neanderthals suffered significant periods of poor nutrition as infants. This also indirectly revealed poor nutrition status of the mothers of these infants since they would have been nursing around the time in which these pits and grooves were being formed. While this 40% sounds dramatically high in the context of today's world, this percentage would have been quite normal in prehistoric times even up to a few hundred or thousand years ago, aligning with that found among prehistoric Inuit from Canada. Therefore, evidence of periodic food shortages may not indicate that the Neanderthals were inept hunter gatherers. Rather, it may simply reflect the risky and unpredictable nature of life faced by hunter gatherers living in cold, hostile environments.

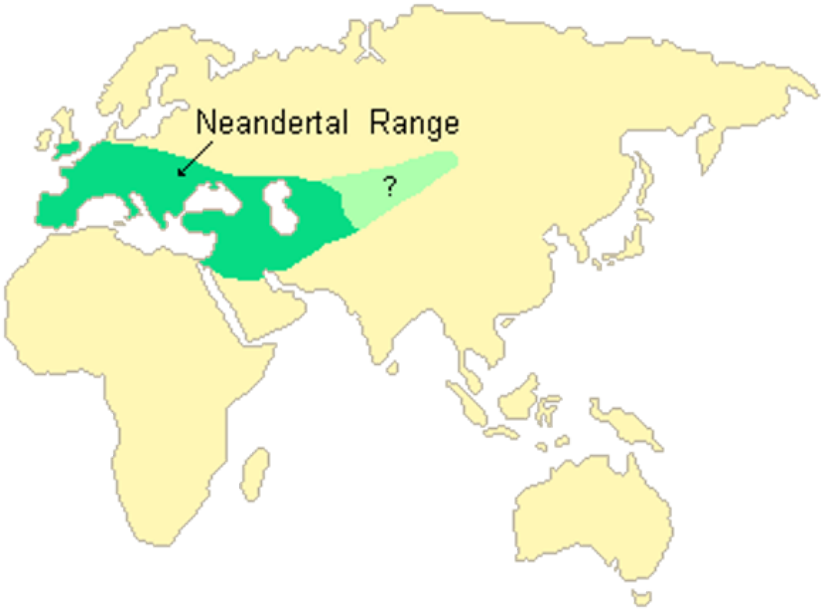
Amidst unstable and often harsh conditions, Neanderthals successfully thrived for more than 300,000 years until they suddenly vanished from the archaeological record around 40,000 years ago when modern humans were first entering into Europe. How and why the Neanderthals disappeared from the record is a hot topic that is yet to be determined. With no definitive evidence to draw upon, the demise of the Neanderthals is one of the most debated issues in paleoanthropology. Endless theories have been proposed, primarily founded upon the idea that modern humans were superior to the Neanderthals, and were thus able to outcompete the Neanderthals for resources. Some of the potential ways by which Neanderthals may have been inferior to modern humans have already been discussed in this summary taking into account differences in creativity and innovation, calorie needs, food processing technologies, the breadth of dietary diversity and more. While all of these distinctions drawn between modern humans and Neanderthals may very well give us clues to why we modern humans survived and the Neanderthals did not, none of these differences can be conclusively pinned as the underlying cause of the Neanderthal extinction. Some scientists argue that these differences

were not even great enough to explain the Neanderthals' demise. Furthermore, others assert that the Neanderthals may not have gone extinct at all. Instead, they may have been effectively absorbed into the modern human population by way of complex processes of interbreeding and assimilation, resulting in the disappearance of the 'classic' Neanderthal morphology from the record and the continuation of the Neanderthal genome in modern humans. With low populations to begin with, the complete absorption of the Neanderthals into the much larger modern human population would not have taken long. In the end, the answer to why and how the Neanderthals vanish from the record may never be truly solved, remaining as one of the many mysteries of our Neanderthal cousins.

Research

Environment

Stomping Grounds:



(Photo Courtesy of O'Neil, Dennis <http://anthro.palomar.edu/homo2/mod_homo_2.htm>).

"Where Lived: Europe & southwestern to central Asia" (Smithsonian National Museum of Natural History. "Homo Neanderthalensis.").

"Neanderthals' core area - the region inhabited continuously by Neanderthals from their first appearance onward-was southwestern France, Spain, Italy, and the western Mediterranean. This core area had Mediterranean and sub-Mediterranean climates and also served as

Neanderthals' final refugium once modern humans appeared in Europe."(Shipman, Pat p. 14241).

"At first, Neanderthals were restricted geographically to Europe, but by the time true Neanderthals appeared about 200,000 years ago they had begun to move into western Asia. Eventually they moved as far east as Uzbekistan (north of Afghanistan) and throughout much of the Middle East. The last Neanderthals appear to have been restricted to the Iberian Peninsula (modern Spain and Portugal), where the last one died sometime after 30,000 years ago." (Wynn, Thomas & Coolidge, Frederick L. p. 2).

“Evidence of Neanderthal habitation in Gibraltar between 28,000 and 24,000 BC has been discovered at Gorham’s Cave, making Gibraltar the last known holdout of the Neanderthals.” (Wikipedia Online Encyclopedia “Gibraltar”).

A Wide Range of Environments & Climate Instability

“...for much of the Neanderthal time range, Western Eurasia was dominated by a biotope that has become known as the Mammoth steppe...a highly productive habitat which supported a very diverse grazing community with the mammoth as its characteristic species...climate instability has dominated the North Atlantic climate over the last 230,000 years, i.e. a major part of the Neandertal period...Neandertals were present in a wide range of environments.” (Roebroeks, Wil ed. p. 251).

“...European Neandertals were living in relatively cold conditions.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1126).

“Contrary to their cold-adapted image, Neanderthals inhabited Pleistocene Europe during a time of great climatic fluctuation with temperatures ranging from as warm as present-day during the last interglacial to as cold as those of the last glacial maximum. Cold-adapted Neanderthals are similarly most often associated with the exploitation of large mammals who are themselves cold-adapted (mammoth, bison, reindeer, etc.).” (Hardy, Bruce L. p. 662).

"The western Neanderthals persisted for at least 200,000 years…dating from 230,000 years ago…to approximately 32,000 years B.P. During this period, Europe passed through some of the most severe of the Quaternary ice ages, and there is some evidence that the Neanderthals penetrated to the north and retreated to the south as the ice retreated and advanced." (Friedmann, Theodore; Dunlap, Jay C.; Goodwin, Stephen F. p. 34).

“At times, Neanderthals lived in regions and times with temperatures as warm as or warmer than today such as OIS5e (132–115kya, Shackleton et al., 2002). By contrast, Neanderthals also inhabited extremely cold steppe and tundra conditions...” (Hardy, Bruce L. p. 665).

“We know that Neandertals remained in Europe during the Ice Ages, but the archaeological evidence suggests that they abandoned many areas during the episodes of extreme cold…What is clear is that Neandertals evolved in Europe during a time of fluctuating climates that included several long, cold phases that lasted for tens of thousands of years…” (Wynn, Thomas & Coolidge, Frederick p. 10).

Time Range

“The first humans with proto-Neanderthal traits are believed to have existed in Eurasia as early as 600,000–350,000 years ago.” (Wikipedia, the Free Online Encyclopedia “Neanderthal” Accessed 5/23/2014).

"Neandertals were a prehistoric people who evolved in Europe and flourished between about 200,000 and 30,000 years ago." (Wynn, Thomas & Coolidge, Frederick L. p. 1).

“Scientists do not agree when Neanderthals can first be recognized in the fossil record, with dates ranging 200,000 and 300,000 years BP.” (Wikipedia, the Free Online Encyclopedia “Neanderthal” Accessed 5/23/2014).

“When Lived: About 200,000 - 28,000 years ago.” (Smithsonian National Museum of Natural History “What does it mean to be human? - Homo neanderthalensis.”).

Their Evolution

“Comparison of the DNA of Neanderthals and Homo sapiens suggests that they diverged from a common ancestor between 350,000 and 400,000 years ago. This was probably Homo heidelbergensis.” (Wikipedia, the Free Online Encyclopedia “Neanderthal” Accessed 5/23/2014).

Whether or not H. heidelbergensis was the last common ancestor of modern humans and Neanderthals is a point of major debate ultimately due to an absence of evidence: “Estimates based on DNA show that the last common ancestor of H. sapiens and Neanderthals lived around 400,000 years ago. This made H. heidelbergensis, a widespread species alive at the time, seem like a good candidate for that ancestor. The new study contradicts this idea. The tooth reconstruction of the last common ancestor of humans and Neanderthals created by Gómez-Robles and colleagues doesn't match the teeth of H. heidelbergensis. In fact, the researchers found that none of the human species living during the time predicted by genetic data fit the tooth pattern generated by the new study. More than that, "European species that might be candidates show morphological affinities with Neanderthals," Gómez-Robles says, which hints that these humans were already on the Neanderthal side of the split. This suggests that the last common ancestor of H. sapiens and Neanderthals lived sometime earlier, perhaps as far back as one million years ago.” (Switek, Brian Oct 2013).

"Neandertals evolved in Europe from an earlier hominin known as Homo heidelbergensis. We 'modern' humans also evolved from Homo heidelbergensis, but in Africa. Fossil and genetic evidence indicates that these two groups separated from one another about half a million years ago, long enough for differences to evolve, but perhaps not long enough for them to become separate species, which would require that they not be able to breed and produce fertile offspring." (Wynn, Thomas & Coolidge, Frederick L. p. 2).

"Between 128,000 years ago and 180,000 years ago there was a very long, intense Ice Age, and it was during this one that the 'classic' Neandertals anatomy evolved." (Wynn, Thomas & Coolidge, Frederick p. 10).

Morphology

Facial Features

"The distinctive features of H. neanderthalensis include a face that projects forward in the midline, a large nasal opening, a rounded top and back of the cranium, a cranial capacity that is on average larger than that of modern humans, and distinctive limb bones with thick shafts and large joint surfaces." (Henry, Amanda G. & Wood, Bernard, edited by Ungar, Peter S. p. 21).

"Their jaws were big with long rows of square teeth, but their chins were small, almost as though the middle part of their face had been pulled out slightly around their nose and upper lip…The thick brow ridge that ran over their eyes gave them a brooding, almost sinister look, even if their heads were topped, as some scientists have speculated, with mounds of red or blond hair. Their hair color and their fairer, possibly freckled skin were an evolutionary accommodation to living farther north than the Homo sapiens from the warmer climates to the south. Dark skin in equatorial environments evolved to reduce the amount of vitamin D we absorb, but light skin increases our absorption rate, a good thing in lands where sunshine is in short supply for half the year." (Walter, Chip p. 105).

"One of the Neandertals tested by Paabo had the gene for red hair…" (Wynn, Thomas & Coolidge, Frederick p. 8).

"Some anthropologists think that for Neandertals, nose size may instead be linked to their high level of exertion, during which any ability to take in and breathe out larger volumes of air through the nose might be an advantage." (Wynn, Thomas & Coolidge, Frederick p. 11).

Body Type Ideal for Power

"He would be fairly short, about the same height as…Jon Stewart of The Daily Show. But he would be much more massively built. His torso would be broad and deep, with wide hips and a barrel chest. He would be heavily muscled and would likely resemble the bodybuilders at the gym, or perhaps the competitive weight lifters. But he wouldn't have had to invest nearly the time or reps to get his physique; he was by nature very muscular…His arms and legs would be a bit short for his stature, especially his forearms and lower legs. This body type is ideal for

power…It is unlikely that any but the strongest of modern people could match him." (Wynn, Thomas & Coolidge, Frederick p. 3).

“The Neanderthals were extremely robust, heavily muscled people with broad, thick chests, large, long, relatively low globelike skulls, and large, long prognathic faces. In the first detailed studies, the vertebrate paleontologist Marcellin Boule and some contemporary investigators concluded that the Neanderthals were apelike in posture, foot structure, and other important features. However, it is now clear that they were indistinguishable from modern people in these characters and, more generally, in the basic structure and function of their limbs and muscles. The postcranial [below the head] differences between the Neanderthals and modern people relate mainly to the Neanderthals’ extraordinary robusticity (muscularity) and their extreme adaptation to cold climate.” (Klein, Richard G. p. 450).

“The large, well-developed muscle and ligament markings on the bones of Neanderthal limbs and extremities indicate exceptional muscular strength (muscular hypertrophy).” (Klein, Richard G. p. 456).

"Their hands were large and far more powerful than their Homo sapiens cousins'…" (Walter, Chip p. 105).

“The great strength of the Neandertal upper limb is also reflected in the anatomy of the hand...Many features of the hand skeleton of Neandertals suggest that they had a bone-crushing grip.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1140).

“The proportions and morphology of the hand bones imply that Neanderthals resembled living humans in dexterity and in the ability to grip precisely, but that they could squeeze harder between the thumb and the other fingers when they gripped hammerstones or other objects. The overall morphology of the scapula reflects the power of the upper arm muscles that attached to it; hypertrophied development of some of these muscles would have destabilized the arm during throwing or striking if another muscle had not shifted its attachment on the scapula, producing the groove on the outer border of the dorsal face. The cortical thickness of the leg bones may reflect an ability to endure long periods of intensive use.” (Klein, Richard G. p. 456).

“...Neandertal foot bones are generally robust, implying high levels of activity related stress.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1148).

“...Neandertal long bones generally have thicker cortical bone, stronger indicators of muscle attachments, and bigger joint surfaces than those of living humans. All of these features imply that Neandertals and other archaic humans were able to exert high levels of muscular force throughout the full range of movements at most joints.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1137).

“All of these features of Neandertal limbs suggest that these ancient Europeans were powerfully built people, whose bodies were adapted to generating and resisting strong muscular forces.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1149).

“The bowing of the radius and femur has sometimes been attributed to rickets (vitamin or hormone D deficiency), but it also tends to characterize yet earlier people, and neither they nor the Neanderthals exhibit other diagnostic bony markers of rickets. More likely the bowing is related to the extraordinary muscularity of all premodern people, including the Neanderthals.” (Klein, Richard G. p. 456).

A Body Type for Retaining Heat

"Neandertals…evolved a classic body type for retaining heat: relatively short and compact, with short arms and legs. This explanation is so compelling that paleoanthropologists have tried to incorporate other Neandertal features into it, arguing that Neandertal noses evolved to warm and moisten cold air. However, recent research points to heavy chewing as a more likely explanation for the unusual features of the Neandertal face." (Wynn, Thomas & Coolidge, Frederick p. 9).

“...bulkier build will conserve heat by decreasing the surface-to-volume ratio.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1126).

“...a strikingly cold-adapted body build for Neandertals (especially the European ones), with short limbs and a deep, wide trunk.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1129).

"The selective pressures of cold, northern climates also endowed Neanderthals with big, rounded shoulders and thick-barreled chests…" (Walter, Chip p. 105).

"So how cold-adapted were Neandertals?…The anatomical evidence suggests that they were perhaps not much more cold-adapted than cold-adapted modern people such as the Inuit…Neandertals were probably more cold-adapted than modern Europeans, but not by much. They would have been unable to live in Ice Age Europe without the aid of cultural mechanisms for keeping warm: fire and clothing." (Wynn, Thomas & Coolidge, Frederick p. 11).

Stature, Body Weight, BMI

"…they were NOT shorter than the Homo sapiens of their time, though they were shorter than their direct ancestor, Homo heidelbergensis, who stood six feet tall…" (Walter, Chip p. 105).

"…the completely articulated skeleton has generated a more reliable stature estimate for an Upper Pleistocene adult male Neanderthal, measuring 163.8 cm [5 ft., 4.5 inches]…" (Sawyer, G.J. & Maley, Blaine p. 30).

"Based on 45 long bones from maximally 14 males and 4 females, Neandertals' height averages between 164 and 168 (males) resp. 152 to 156 cm (females). This height is indeed 12-14 cm

lower than the height of post-WWII Europeans, but compared to Europeans some 20,000 or 100 years ago, it is practically identical or even slightly higher. Considering the body build of Neandertals, new body weight estimates show that they are only slightly above the cm/weight or the Body Mass Index of modern Americans or Canadians. The calculation of the relative surface area (approximately 240-244 cm2/kg) is very low and supports earlier findings of a morphological and anatomical thermoregulatory adaptation to a cold climate in the Neandertals." (Helmuth, H. p. 1).

“Adaptation to cold probably explains the great breadth of the Neanderthal trunk, the shortness of the limbs, and especially the shortness of the forearm and lower leg...In their great trunk breadth and short limb length, the Neanderthals as a group equaled or exceeded the Inuit (or Eskimo), although the Neanderthals probably experienced less extreme cold. This suggests that relative to the Inuit, the Neanderthals relied more on physiology and less on culture as a buffer to cold.” (Klein, Richard G. p. 457-458).

"From a statistical point of view, no height differences are shown to exist between the Western European and the Western Asian/Near Eastern Neandertals." (Helmuth, H. p. 11).

"Newly published estimates of body size, i.e. weights, of Pleistocene hominids give the body weight of Neandertals as 76 kg compared to the weight of modern humans 'living worldwide.' at 58.2 kg…The cm-weight of the Neandertals varies from 4.52 to 4.63 which according to modern standards is 'normal.' Secondly, the Body Mass Index varies between 2.69 and 2.82 and rates as 'corpulent.' " (Helmuth, H. p. 9).

“Body-mass estimates for Neandertals are greater than those for other Homo - including late Middle Pleistocene hominins, early modern Europeans, early modern Western asians, and worldwide averages for living humans. Evidently, Neandertals had relatively high lean body mass. Conversely, estimates of Neandertal stature indicate that they were shorter than any of these other people. This combination of short stature and heavy weight means that the average Neandertal was exceptionally stocky and robustly built.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1122 & 1123).

Calorie Needs: *Similar to that of a Professional Athlete During Training*

“A number of recent studies have concluded that Neandertals had a higher basal metabolic rate (BMR) than Anatomically Modern Humans (AMH) due to a higher body mass and different shape. According to Churchill, Neandertal BMR was about 25% greater than that of modern humans. Based on this high BMR, estimates of total energy expenditure (TEE) of Neandertals are proportionally high. Churchill (2006) estimates that it took on average between 3500-5000 kcal per day to feed an adult Neandertal.”(Roebroeks, Wil ed. p. 253).

“An average Neandertal needed somewhere between 3,000 and 5,500 calories per day…using body weight and estimates of levels of physical activity based on the robusticity of bones and the pronounced areas for muscle attachment…maintaining body heat was a metabolic

requirement that elevated the daily calorie requirements. The estimated 3,000 to 5,500 calories is a lot of calories, roughly comparable to that consumed by a professional athlete during training." (Wynn, Thomas & Coolidge, Frederick p. 23).

"Steegman et al. (2002) have estimated that Neanderthals may have required 3360–4480 kcal per day." (Hardy, Bruce L. p. 670).

"To stay warm and maintain their enormous strength, some scientists have theorized, they required up to 350 calories more a day than their Homo sapiens counterparts. Today 350 calories might not seem like much, nothing more than an extra muffin at Starbucks, but fifty thousand years ago that much extra food would have been exceedingly difficult to come by day in and day out." (Walter, Chip p. 105).

"What we know of Neandertal biology suggests that maintenance, survival, and growth would have required almost all of the energy the Neandertal diet could provide, leaving precious little surplus for reproduction. It seems correspondingly likely that Neandertals must have had lower long-term fertility rates than modern humans." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1157).

"What evidence we have about Neandertal subsistence suggests that it...[involved] high activity levels, rapid metabolic turnover, and a lot of meat and other high-calorie foods in the diet." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1173).

"...Neandertals had a powerful thorax, capable of moving large amounts of air in and out rapidly. This is in keeping with the Neandertals' large nasal openings, muscular bodies, and impressive body masses...Neandertals may have evolved to serve the respiratory demands of high activity levels in cold, arid environments. The large size of the Neandertal thorax implies that the enclosed heart and lungs were unusually big, probably for the same reasons...Churchill (2006) calculates that an adult Neandertal would have required 3500-5000 kcals a day to survive in cold conditions. He suggests that the expanded thorax...[was]...an adaptation for providing the increased flow of oxygen needed to metabolize all those calories." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1128-1130).

"Take their [Neanderthal's] barrel chests…perhaps their lives of heavy exertion led to enlarged chests; heavy exertion also puts stress on an individual's ability to process oxygen." (Wynn, Thomas & Coolidge, Frederick p. 5).

Skull & Brain Compared to a Modern Human

"Some defining features of their skulls include the large middle part of the face, angled cheek bones, and a huge nose for humidifying and warming cold, dry air." (Smithsonian National Museum of Natural History. "Homo Neanderthalensis.").

“...around 200,000 years ago, Neandertals and modern humans appear on the scene, with skulls capable of holding 1,400 c.c. of brain, and sometimes considerably more.” (Allen, John S. p. 51).

“A Neanderthal brain volume equals or exceeds modern human dimensions, ranging from about 1200-1750 ml, and thus on the average about 100 ml larger than modern humans.” (Phillips, Dave).

"Neandertal brains were about 10 percent larger, on average, than modern brains, and so were their heads." (Wynn, Thomas & Coolidge, Frederick p. 3).

"Neandertal brains did differ from modern brains in both size and shape…Neandertal brains were bigger than modern brains, about 10 percent bigger. Modern brains average about 1,300 cubic centimeters; Neandertals averaged 1,427 cubic centimeters…Most anthropologists accept that Neandertals had slightly larger brains, on average, than modern people. But were they 10 percent smarter? We don't think so." (Wynn, Thomas & Coolidge, Frederick p. 13).

"…the size and shape of his brain case…would be large, probably larger than yours. It would be longer than yours, and it would be widest midway between the base and the top, so that from the rear it would appear round. (Your widest point is much closer to the top.)" (Wynn, Thomas & Coolidge, Frederick L. p. 3).

Diet

Meat Intake

The Neanderthal Diet in the more Northern Latitudes: Dominated by Large Herbivores---

"For Neandertals living in northwestern Europe, the two primary sources of animal protein were mammoth and woolly rhinoceros…" (Wynn, Thomas & Coolidge, Frederick p. 25).

“We reported here the carbon and nitrogen isotope results from collagen extracted from a Neanderthal tooth and bone from various species of fauna from the site of Jonzac [France]. By comparing the isotopic results from the Neanderthal with contemporary fauna from the site, we conclude that the Neanderthal [from france] obtained its dietary protein mainly from large herbivores, namely bovids and horses. The Neanderthal isotopic result matches well with previously published results for Neanderthals from France, Belgium, and Croatia and adds to the emerging picture of a conservative and clearly successful dietary adaptation in Neanderthals of hunting large herbivores.” (Richards, M.P. & Taylor G. et. al. p. 184).

The isotopic analysis of the bone collagen of 4 adults, and 12 specimens of bone from Goyet in Belgium (Northwestern Europe —mammoth steppe) revealed the relative proportions of animal

sources of protein in the diet. Since bone collagen reflects the average protein input of the most recent years, it provides information on the average dietary intake over a longer time span.
The relative proportions of meat intake from different species (Note: not their absolute values in terms of total dietary intake)—
Mammoth meat : 10-60%, but most likely within the range of 20-40%
Rhino : 20%
Reindeer : 25%
Horse & Bovid : 0-10% (WiBing, C. et. al.).

This study and all previous isotopic studies categorize Neanderthals as carnivores. Although it is important to note due to methodical constraints in the identification of plants via isotopic analysis, this method can result in an underestimation of the contribution of plant food to the diet.

Of the carnivores living alongside the Neanderthals in this mammoth steppe environment, Neanderthals were the primary predator of mammoth. Neanderthals intensely relied on mammoths, and of the predators, Neanderthals included the highest amounts of mammoth meat in their diet.
(WiBing, C. et. al.).

Our Note: This study by WiBing, C. et. al. was performed on Neanderthals living in northwestern Europe in an environment thought to have been rich with mammoth and other large herbivores such as rhinoceros. It will be interesting to see similar analysis in Southern Europe in an environment other than the mammoth steppe where large herbivores may not have been as abundant and more plant foods may have been available. More plant foods and smaller animals such as birds may have been consumed in these environments.

Our Note: In the Spy cave (Belgium), a collection of juvenile mammoth skull elements was found. If these remains were the leftovers of a Neanderthal feast on mammoth brains, these Neanderthals would have feasted upon one of the richest sources of long-chain omega-3 polyunsaturated fatty acids available on land — the mammalian brain. (WiBing, C. et. al.).

The Spy (Belgium) Neanderthals had a highly carnivorous diet but also regularly consumed mushrooms.:
“Bones of woolly rhinoceros, reindeer, mammoth, and horses were present in Spy Cave, while wild mouflon sheep were broadly distributed in Europe throughout the Pleistocene. Woolly rhinoceros has long been suspected to be part of the Spy Neanderthal diet, confirming the highly carnivorous lifestyle inferred from the isotope and dental microwear data obtained from the Spy individuals. These findings also support recent isotope evidence that suggests Spy Neanderthals were regularly consuming mushrooms.” (Weyrich et al. 2017).

Neanderthal Diet in Southern Latitudes (i.e. modern-day Spain, Israel)

“Overall, central and northern European Middle Paleolithic faunal assemblages are typically characterized by ‘‘their lack of diversity and their focus on large to medium-sized terrestrial herbivores’’ Farther to the south, in northern Spain and southwestern France, there is an increase in the percentage of medium-sized herbivores (e.g. red deer, ibex, chamois), although larger game (horse, bison, rhino, elephant) are also present. As with central and northern Europe, evidence for a diverse diet including small game, birds, fish and shellfish is rare, although there are some exceptions. Southeastern France and northwestern Italy show a similar emphasis on medium to large herbivores, with red deer as a dominant prey species (Valensi and Psathi, 2004). The pattern of large and medium-sized terrestrial prey is also found elsewhere along the European Mediterranean region (Burke, 2000; Aura Tortosa et al., 2002).” (Hardy, Bruce L. p. 663-664).

"Neanderthals at these sites [in Gibraltar] exploited marine resources and a broad range of terrestrial resources, ranging from rabbit - the most abundant species (by # of specimens) in Gorham's Cave at both levels - to red deer and, in Gorham's Cave, rhinoceros." (Shipman, Pat p. 14241).

“...hafted points used as spears are not only found in Africa. Neandertals and even the preceding Homo heidelbergenesis were effective hunters; at La Borde, for example, Neandertals hunted prime-aged adult aurochs [ancestors to domestic cattle]...small resource use is also evidenced by coastal Neandertals, who ate shellfish at Gibraltar...Neandertals also ate small foods like turtles, nuts, and shellfish in good measure.” (Kusimba p. 129-130).

"The Kebra [from the region of present day Israel] Neandertals, like all Neandertals, were adept hunters. Here their focus was primarily on gazelle, which are relatively small for ungulates…Together gazelle and fallow deer made up about 80 percent of the faunal remains, suggesting a bias in the hunting strategy. Occasionally the Kebara Neandertals also killed wild cattle and boar, which are both potentially dangerous, confirming the Neandertals' willingness to face ferocious prey. They also collected tortoises, which probably were not as ferocious." (Wynn, Thomas & Coolidge, Frederick p. 28-29).

“Middle Paleolithic exploitation of small prey has been documented at lower latitudes, largely confined to “gatherable” food items (marine molluscs, tortoises, legless lizards and ostrich eggs...). The limited evidence for the use of relatively fast-moving small game (such as rabbits or game birds) has been interpreted as indicating lower Neandertal dietary breadth compared with later humans in this region.” (Roebroeks, Wil ed. p. 252).

Oral microbiota of Neanderthals from different locations reflects varying amounts of meat in the diet

“Differences in diet were also linked to an overall shift in the oral bacterial community (microbiota) and suggested that meat consumption contributed to substantial variation within Neanderthal microbiota…DNA preserved within dental calculus represents a notable source of

information about the behaviour and health of ancient hominin specimens, as well as a unique system that is useful for the study of long-term microbial evolution." (Weyrich et al. 2017).

"The composition of the oral bacterial population in Neandertals and both ancient and modern humans correlated closely with the amount of meat in the diet, with the Spanish Neandertals grouping with chimpanzees and our forager ancestors in Africa. In contrast, the Belgian Neandertal bacteria were similar to early hunter gatherers, and quite close to modern humans and early farmers." (University of Adelaide 2017).

Results & Implications of Carbon & Nitrogen Studies
Neanderthals were top-level carnivores who acquired most of their protein in the form of animal protein:

"Stable-isotope studies, comparing ^{15}N levels in Neandertal bones from Belgium, France, and Croatia with those of various animals with differing diets from the same regions, show Neandertals clustering with species that get their protein nearly exclusively from meat." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1176).

"The evidence from archaeozoological studies of faunal remains uncovered at Neandertal sites as well as stable isotope studies of their skeletal remains indicate that animal products formed an important part of their diet...the isotope studies tell us that they were top level carnivores...prey species varied from reindeer at Salzgitter-Lebenstedt (Germany...) to aurochs [the ancestor of domestic cattle] at LaBorde (France...) and forest rhino at the last interglacial site of Taubach (Germany...)." (Roebroeks, Wil ed. p. 252).

"The isotopic data indicate that in all contexts Neandertals had similar, or slightly higher, δ15N values than associated carnivores from the same sites. This is interpreted as indicating that Neandertals obtained their protein largely from meat from large herbivores....The Neandertal isotope data is remarkably consistent, despite being from geographically and temporally disparate sources...Neandertals were consistently hunting and consuming large herbivores." (Roebroeks, Wil ed. p. 227).

Did the Neanderthals obtain Scavenged Meat? "…when compared to hyenas, the local scavengers and opportunistic hunters, Neandertals fell much higher "up" on the carnivorous scale. They do not appear to have done much scavenging…" (Wynn, Thomas & Coolidge, Frederick p. 25).

"…the hyenas and the Spy Neanderthals obviously had different ecological niches suggesting that both species were not in direct competition for food resources and the Neanderthals were not a kind of scavenger, but rather a kind of hunter-gatherer." (Naito, Y.I. et. al. p. 88).

Hunting

The Neanderthals were Effective Large-Game Hunters

“...there is ample evidence that the large-brained Neanderthals (who lived from about 30,000 years ago to 150,000 years ago) were quite effective large-game hunters...” (Allen, John S. p. 49).

"…the left-right asymmetry of arm bones in Neanderthals probably reflected spear thrusting (rather than throwing) to kill prey." (Shipman, Pat p. 14241).

"Neandertal groups zeroed in on one or two varieties of ungulates, at least whenever possible. They didn't focus on size; they focused on a small range of species." (Wynn, Thomas & Coolidge, Frederick p. 42).

"Together the archaeological and chemical evidence indicates that Neandertals were not just carnivores; they were "top predators," successfully hunting the largest and most dangerous herbivores on the European landscape."(Wynn, Thomas & Coolidge, Frederick p. 25).

"…the picture that is unfolding is one of a formidable hunter, capable of killing even the adults of Eurasia's largest and most dangerous Ice Age animals." (Speth, John D. & Tchernov, Eitan p. 53).

“There is persuasive evidence of Neandertal exploitation of shellfish in Italy (Stiner 1994) and Gibraltar (Barton 2000). Among the most common prey animals found in Eurasian sites are aurochs (wild oxen), bison, red and fallow deer, reindeer, horses, wild goats and sheep, elephants (mammoth), and rhinoceros....aurochs, bison, and red deer are large and formidable prey; and it is clear from the faunal remains at Mousterian sites that Neandertals relied heavily on the hunting of big game and the exploitation of other animal resources in meeting their energetic needs.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1173-74).

“Some sites show considerable specialization on certain species...reindeer...bison...rhinoceros...aurochs...horses...mammoth...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1174).

“...fossils of the extinct cave bear (Ursus spelaeus) remains are numerous...This might be taken as evidence that Neandertals were hunting cave bear as well...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1175).

“...all the evidence points to Neandertals as effective and efficient predators on a wide variety of large Pleistocene mammals. This interpretation is further supported by analyses of Neandertal skeletal injuries, which are similar to those seen in rodeo riders who work in close contact with large ungulates.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1177).

“...the systematic rejection of the juvenile carcasses at Mauran must be considered. This suggests that, in both cases, exploitation was centered on the individuals which were of greater

interest in terms of the quantity of meat, marrow, and perhaps grease.” (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 55).

Hunting Tactics

Focus on a narrow range of large mammals and shift down food pyramid as needed, Communal & Seasonal Hunting, Use of Landscape to trap or injure, Surprise & Ambush prey, & The use of stone-tipped thrusting spears

"Neandertals were pedestrian hunters armed with single thrusting spears." (Wynn, Thomas & Coolidge, Frederick p. 33).

"…at times, the Neanderthals engaged in hunting that required extensive cooperation by groups." (Mithen, Steven J. p. 238-239).

"To summarize, Les Pradelles and Mauran share all the characteristics (large quantity of faunal material, specialized faunal spectrum, large number of prey, catastrophic mortality profile, seasonal slaughter, possible selective transport of the richest elements) of specialized hunting (sensu David and Enloe, 1993). This communal hunting involved the planned procurement of animal resources, very likely with the intention of storing the surplus in anticipation of future needs. Such hunting strategies require the participation of a large number of individuals. They also imply an important degree of communication among participants, active cooperation, and a defined role for everyone: thus, a social organization (e.g. Kurz, 1937; Frison, 1978; Morgan, 1980). This communal hunting implies the systematic scheduling of activities to form a year-round pattern or “annual round”." (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 55).

"The repeated use of specific locations at a precise moment of the year so as to acquire and process carcasses of particular taxa is evidence of hunting activities that are scheduled according to a year-round pattern." (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 56).

“The question of specialized hunting conducted by Neanderthal populations was investigated in two major Mousterian sites in Southwestern France….it has been shown that, in these late Mousterian sites, communal hunting involved deferred consumption in anticipation of future needs...[However, the question remains]…"Does this kind of hunting strategy show cultural elements shared by the whole Neanderthal population or, on the contrary, does it reflect a regional variation which characterized the Mousterian population of Southwestern Europe at a particular period?" (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 56).

"…Neandertals apparently relied on landscape features to provide a local advantage. In the case of La Cotte, they not only immobilized the mammoth, but they also injured them with a

fall…Neandertals did not have long-range projectiles and could not stand back at a safe distance launching missiles at the injured mammoth. Instead they used stone-tipped thrusting spears…The use of landscape features suggests that Neandertals were effective tactical hunters…" (Wynn, Thomas & Coolidge, Frederick p. 27).

"The promontory of La Cotte still marked the abrupt end of a plateau, however, with a cliff plunging 50 meters to the ground below. The eleven mammoth and three rhinoceros apparently took that plunge in one terrifying, chaotic event…Something stampeded these animals, terrifying them into a frenzy, so that when the leaders of the stampede reached the cliff edge and tried to stop, their herd mates behind them pushed them over…This is not how lions and hyenas, both of which were on La Cotte's landscape, usually hunt. But people sometimes do. And the most dangerous carnivore on the landscape at the time was Neandertal." (Wynn, Thomas & Coolidge, Frederick p. 22-23).

"One site that dates back 125,000 years reveals that a group of Neanderthals living in a cave at La Cotte de Saint Brelade drove mammoths and rhinoceros over a nearby cliff, butchered the dead or writhing animals on the spot, and then hauled in the choicest cuts into their nearby caves before any hungry predators could get to them." (Walter, Chip p. 106).

"Neandertals did not hunt mammoth and rhinoceros exclusively. In fact the mammoth bias may have been true only of Neandertal groups living on the Ice Age plains of northwest Europe. Other sites suggest a more eclectic approach to being a top predator. The Neandertals who hunted at Salzgitter-Lebenstedt in modern Germany were going after reindeer, and not just any reindeer; they focused on prime adult males. Here again we see the use of terrain to handicap prey. In this case, Neandertals maneuvered a reindeer herd, or part of a herd, into a steep, narrow valley to cut off the possibility of escape and then killed them with spears." (Wynn, Thomas & Coolidge, Frederick p. 27).

"Mauran, in the foothills of the Pyrenes. This is where a massive accumulation of bison bones was excavated close to a steep riverside escarpment. It appears that the Neanderthals forced small herds of bison off the cliff edge, which then fell to their deaths. To do so, several, perhaps many, hunters would have worked together to stampede the animals. The slaughters at Mauran appear to have occurred towards the end of the Neanderthal occupation of Europe, probably around 50,000 years ago. Considerably earlier, at around 125,000 years ago, a similar hunting technique was used at La Cotte on the Channel Island of Jersey." (Mithen, Steven J. p. 238).

"Neandertals here [in the Caucasus Mountains] focused their energies on the local species of mountain goat, the Caucasian tur…Here again we see that Neandertals biased their hunting toward prime adults, but this time both males and females…Neandertals simply needed to find a hiding place near a regular tur migration path and ambush them when they passed." (Wynn, Thomas & Coolidge, Frederick p. 28).

"In summary, Neandertals were the top predator on the landscape wherever they lived. They focused their hunting on a narrow range of large mammals and shifted down the food pyramid only if pressed. In some regions, such as northern Europe, they hunted mammoth and rhinoceros, and were thus perhaps the only prehistoric people ever to have focused on these dangerous beasts. But Neandertals were adaptable and able to switch focus to whatever large mammals a region had to offer. Their tactics relied on an intimate knowledge of local landscapes, an ability to surprise and ambush prey, and the raw courage to kill them at close range using thrusting spears. They hunted in small groups that included women and children. There was no serious division of labor, except with regard to which task someone performed. Even though they focused on only a few species, they did not travel long distances in pursuit. They hunted in relatively small territories, rarely over 1,000 square kilometers (380 square miles), often just up and down a major river valley. They rarely ventured outside of their home territories. They knew every boulder, cliff, and defile, and used them to advantage. But their focus on a few species and relatively small territories meant that their hunts often failed and they went hungry for days. When they did have a successful kill, they had to gorge themselves in order to average the 3,500 to 5,500 calories per day necessary for their survival." (Wynn, Thomas & Coolidge, Frederick p. 46).

Seafood Intake

Insignificant in terms of the overall diet, but may have played a more important role in the diets of Neanderthals living near the coast. Most evidence suggests that the seafood was gathered from the shoreline and was not the result of any form of intensive exploitation. However, this is a point of debate with some scientists standing in support of the theory that the Neanderthals acquired seafood by way of focused practices that were carried out seasonally and over long periods.

Isotopic Evidence (from nitrogen isotopes in bone collagen) does not support the significant consumption of aquatic protein

"...in all cases, the authors of the various studies concluded, as we have for Jonzac, that the main source of dietary protein was animal protein, likely from large herbivores. In no case do we see isotopic evidence for the significant consumption of aquatic (marine or freshwater) protein...The results of our isotopic study of the Jonzac Neanderthal therefore support the emerging picture from isotopic studies that Neanderthals have a similar dietary adaptation over a wide range of environments and over a relatively long period of time." (Richards, M.P. & Taylor G. et. al. p. 184).

No evidence of a significant portion of aquatic foods in the diet

"There is no evidence of any significant contribution of aquatic foods, even though these foods were readily available at a number of the locales studied." (Roebroeks, Wil ed. p. 227).

Nevertheless, there is evidence to support the claim that Neanderthals consumed shellfish on occasion, perhaps when the Neanderthals were living near the sea where it could be easily

gathered. Some evidence also suggests that they exploited fish, marine mammals, and maybe even birds, although more evidence is needed to confirm their consumption of birds.
"The vast majority of Middle Paleolithic faunal assemblages thus portray a diet dominated by medium to large herbivores, but there are exceptions to this trend. Numerous examples demonstrate evidence of aquatic resources (Erlandson, 2001). The Gibraltar sites of Devil's Tower (Garrod et al., 1928), Gorham's Cave (Waechter, 1951, 1964; Baden-Powell, 1964; Finlayson et al., 2001), and Vanguard Cave (Barton et al. 1999; Finlayson et al., 2001) all show evidence of shellfish exploitation by Neanderthals. Similarly, Grotta dei Moscerini and Grotta Breuil, Italy, both show extensive evidence of shellfish (Stiner, 1994). Freshwater shellfish and fish are found at Salzgitter-Lebenstedt, Germany (Butzer, 1971; Cohen, 1977). Finally, Figuera Brava in Portugal has evidence not only of shellfish, but also of marine mammal and bird exploitation (Straus et al., 1993; Antunes, 2000). The capture of avian prey by Neanderthals has been suggested elsewhere (Starosele Crimea, Hardy et al., 2001) and although avian remains are known from many sites (e.g. Prolom II, Crimea, Enloe et al., 2000; Gorham's Cave, Gibraltar, Finlayson et al., 2001; Castelcivita, Italy, d'Errico et al., 1998; among others), the lack of cutmarks and bone modification often make it unclear if humans were involved in their accumulation. While this list of alternative resources is certainly not exhaustive, it demonstrates that Neanderthal subsistence should not be characterized as consisting solely of medium to large terrestrial herbivores." (Hardy, Bruce L. p. 664).

Neanderthals living in Gibraltar near the sea almost certainly consumed marine foods including mussel shells, seals, dolphins, and fish. As this was the last known place of habitation of Neanderthals before they went into extinction, some have theorized that it was this access to foods from the sea that allowed these Neanderthals to survive for longer than their inland kin.
"Recent studies suggest that early hominins may have indeed exploited marine resources. Coastal-dwelling Neandertals living 40,000 years ago in Gibraltar (near Spain) almost certainly ate marine animals. Within a cave site, archaeologists led by Chris Stringer identified an ash layer containing a hearth, Mousterian stone tools (almost always associated with Neandertals) and knapping flakes, and an abundance of mussel shells derived from a nearby estuary...These activities consisted of selection and collection of mollusks, transport of the gathered mussels to the cave shelter, fire making in the cave, the use of heat to open the shells, consumption of these mollusks, knapping on the hearth embers, and subsequent abandonment of the site. Deeper excavations in the same area yielded the remains of seals and dolphins from even earlier occupations, along with the bones of terrestrial mammals more typically associated with Neandertal hunting. A few fish remains were also found in these deposits.
The Neandertal evidence from Gibraltar demonstrates once and for all that modern humans are not the only hominin species who ate from the sea (or lake or river). But this finding does not say too much about the antiquity of seafood use -- the Gibraltar Neandertals range at a time when modern humans were the dominant hominin species. Stringer and colleagues even speculate that these Gibraltar Neandertals may have been able to survive longer than their inland kin because of their access to both land and water resources." (Allen, John S. p. 57-58).

“There is also evidence from Gibraltar that when they lived in coastal areas, they exploited marine resources such as mollusks, seals, dolphins, and fish.” (Smithsonian National Museum of Natural History. “Homo Neanderthalensis.”).

“[In the Gorham & Vanguard caves of Gibraltar (Spain)]…marine mammals, fish, and mollusks were systematically exploited by both Neanderthals and modern humans throughout the stratigraphic sequences at these caves.” (Shipman, Pat p. 14241).

"Vanguard Cave [Spain] shows that Neanderthals were not only systemically exploiting terrestrial mammals but also marine mollusks, pinnipeds (seals), cetaceans (whales, dolphins, & porpoises). Their distribution through the stratigraphy suggests that securing marine mammals was not an accidental or isolated practice, but a focused behavior possibly repeated seasonally or over longer periods. Furthermore, at several Gibraltar Middle Paleolithic sites, coastal wildfowl and seabirds (e.g. the Great Auk Pinguinus impennis), were also likely to have been exploited by Neanderthals. Significantly, the range of species exploited and the age distribution pattern of the prey strongly indicate that the coastal exploitation of resources by Neanderthals was not a sporadic and isolated occurrence but one that required a knowledge of the life history of prey and its seasonality. Other Middle Paleolithic sites from Portugal and the South of Spain have yielded remains of mollusks, cetaceans (whales, dolphins, & porpoises), or marine birds. Although evidence of a human role for these marine remains may not be as clear and repetitive as in Gibraltar, their presence should also be considered as reinforcing this behavior in Neanderthals." (Stringer, C.B. et. al. p. 14323).

Marine Mollusks have been found at many sites across the Mediterranean dating to as far back as the Lower Paleolithic (ca. 300 ka) and continuing on through the early Upper Paleolithic. Although no sites show intensive exploitation of marine mollusks, and rather appear to suggest that the consumption of mollusks (and other seafood) was limited to what could be easily collected.

“Marine mollusks have been recovered from sites around the Mediterranean Sea dating as far back as the Lower Paleolithic, when hominins might have started consuming them (ca. 300 ka). During the Middle Paleolithic and the early Upper Paleolithic, humans (Homo neanderthalensis & Homo sapiens) ate mollusks at many sites across the Mediterranean at least as early as the Last Interglacial.” (Colonese, A.C. et. al. 2011).

“We conclude that described use of shellfish resources by Neanderthals (H. neanderthalensis) in S. Spain started ~150 ka (150,000 years ago) and were almost contemporaneous to Pinnacle Point (S. Africa), when shellfishing is first documented in archaic modern humans.” (Cortés-Sánchez, Miguel et. al.).

“The data presented provide compelling evidence that shellfish harvesting was part of the Neanderthal trophic niche at the same time when Modern Humans were also exploiting the coast in South Africa.” (Cortés-Sánchez, Miguel et. al.).

"Recent studies on Middle Paleolithic sites, attributable to the Mousterian, in Gibraltar (e.g. Stringer et. al. 2008) and in the Murcia province of Spain (Zilhão et. al. 2010) have demonstrated that marine mollusks were exploited by Neanderthals in the southern Iberian Peninsula. In Gibraltar, three sites (Devil's Tower, Gorham's Cave & Vanguard Cave) contained evidence for the exploitation of marine resources, including mammals (Pinnipedia -[i.e. Seals] & Delphinidae - [i.e. Dolphins]), fish and mollusks."(Colonese, A.C. et. al. 2011).

Other seafood possibly exploited by Neanderthals includes species of crab & sea urchin: "…Neanderthals also exploited crustaceans (crab - Eriphia verrucosa), echinoderms (sea urchin - Paracentrotus lividus) and fish (e.g. Diplodus spa., Thunnus thynnus), as well as marine mammals (seal -M. monachus, dolphin- Tursiops truncates, dolphin - Dephinus delphis) and seabirds (e.g. Alca impennis)." (Colonese, A.C. et. al. 2011).

Gathering

Plant Intake

Dependent upon the plant availability in different locales:

“The international team analysed and compared dental plaque samples from four Neandertals found at the cave sites of Spy in Belgium and El Sidrón in Spain. These four samples range from 42,000 to around 50,000 years old and are the oldest dental plaque ever to be genetically analysed.
"We found that the Neandertals from Spy Cave consumed woolly rhinoceros and European wild sheep, supplemented with wild mushrooms," says Professor Alan Cooper, Director of ACAD. "Those from El Sidrón Cave on the other hand showed no evidence for meat consumption, but appeared instead to have a largely vegetarian diet, comprising pine nuts, moss, mushrooms and tree bark -- showing quite different lifestyles between the two groups.” (University of Adelaide 2017).

“Here we describe the shotgun-sequencing of ancient DNA from five specimens of Neanderthal calcified dental plaque (calculus) and the characterization of regional differences in Neanderthal ecology. At Spy cave, Belgium, Neanderthal diet was heavily meat based and included woolly rhinoceros and wild sheep (mouflon), characteristic of a steppe environment. In contrast, no meat was detected in the diet of Neanderthals from El Sidrón cave, Spain, and dietary components of mushrooms, pine nuts, and moss reflected forest gathering[2, 3].” (Weyrich et al. 2017).

The Importance of Plants in the Neanderthal Diet, helping to balance out their high meat intake and alleviating the “protein ceiling” ---

“Neanderthals could not live by meat alone. Recent isotopic studies, while often acknowledging this point in passing, still portray Neanderthals as top carnivores.” (Hardy, Bruce L. p. 676).

“While there is no doubt that Neanderthals ate substantial amounts of meat (Bocherens 2009), they were not obligate carnivores.” (Hardy, Karen; Buckley, Stephen; Huffman, Michael p. 874).

The Protein Ceiling for the Neanderthal Diet would have been around 50 to 65% animal food in the diet: This could have been increased with the increased consumption of fat (from fatty portions of the animal carcass), carbohydrates (from plants), or eating more seafood....
“if Neanderthals were consuming a diet with large amounts of energy from animal protein, it would have to be balanced with fat or carbohydrates. Using data derived from the Ethnographic Atlas, Cordain et al. (2000) calculate the percent of energy derived from different macronutrients (protein, fat, and carbohydrate) for diets with different plant-animal ratios. For their most animal dominated diet, 35% plant to 65% animal, the animals consumed would have to have 10% body fat in order not to exceed maximal hepatic urea synthesis. Since wild animals typically have <5% body fat, Neanderthals would have reached a protein ceiling at somewhere between 50 and 65% animal food in the diet. To counter the effects of the protein ceiling, they could increase consumption of fatty portions of the carcass, increase the size of prey, or increase the intake of plant foods (Cordain et al., 2000; Mann, 2000). Since, as discussed earlier, the zooarchaeological record does not demonstrate major changes in carcass processing or significant change in prey size across the Middle Paleolithic, increasing the intake of plant foods seems a plausible course.
One other possibility would be to increase the amount of fish in the diet. Balter and Simon (2006) recently suggested that trace element analysis of the Saint-Cesaire Neanderthal showed that fish could have contributed up to 30% of the diet. While aquatic resources have been documented at some Neanderthal sites(Erlandson, 2001) the consumption of fish by Neanderthals on a regular basis is not well-supported by the zooarchaeological data, but could certainly have provided a dietary option to avoid the protein ceiling for certain Neanderthal populations.” (Hardy, Bruce L. p. 667).

“In environments lacking exploitable vegetal resources during these periods, the ingestion of lean meat with no supplementary lipid source can lead to serious dietary deficiencies, sometimes resulting in death.” (Costamagno, Sandrine p. 209).

The Environment of the Neanderthals may have offered fewer edible food plants than was available in more tropical and subtropical habitats. However, there was still a variety of edible plants available including roots and grass seeds among others ---

"For much of their time in northwestern Eurasia Neandertals lived in a habitat that had little to offer by way of plant foods. The edible plants that are abundant in the tropics and subtropics - fruit, roots, nuts, edible leaves, and so on - are just not as common in northern latitudes…Given Neandertals' geographic distribution in northwestern Eurasia we would predict a diet in which animal products were always important. During Ice Ages this would have been especially true." (Wynn, Thomas & Coolidge, Frederick p. 24).

“Even during cold cycles, however, certain calorie-dense plant foods like grass seeds (Poaceae) and cattails (Typha) would have been available.” (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 486).

"…a landscape that supported more vegetation than is found in the Arctic and subarctic today, especially in the form of grasses and sedges. Of course, Neandertals could not eat most of these plants. They could and did eat a few, such as the roots of certain plants and some of the grass seeds, especially if they were cooked. But such resources would have been relatively few for the Neandertals living in northern Europe." (Wynn, Thomas & Coolidge, Frederick p. 24).

The Direct Evidence of Plant Foods at Neanderthal Sites

“Scientists have identified human fecal remains from El Salt, a known site of Neanderthal occupation in southern Spain that dates back 50,000 years. The researchers analyzed each sample for metabolized versions of animal-derived cholesterol, as well as phytosterol, a cholesterol-like compound found in plants. While all samples contained signs of meat consumption, two samples showed traces of plants -- the first direct evidence that Neanderthals may have enjoyed an omnivorous diet.” (Massachusetts Institute of Technology).

“Each sample contained mostly coprostanol -- evidence of a largely meat-based diet. However, two samples also held biomarkers of plants, which Sistiaga says may indicate a rather significant plant intake. As she explains it, gram for gram, there is more cholesterol in meat than there is phytosterol in plants -- so it would take a significant plant intake to produce even a small amount of metabolized phytosterol.
In other words, while Neanderthals had a mostly meat-based diet, they may have also consumed a fairly regular portion of plants, such as tubers, berries, and nuts.” (Massachusetts Institute of Technology).

“Taken together, these data suggest that the Neanderthals from El Salt consumed both meat and vegetables, in agreement with recent hypotheses based on indirect evidence. Future studies in Middle Palaeolithic sites using the faecal biomarker approach will help clarify the nature, role and proportion of the plant component in the Neanderthal diet, and allow us to assess whether our results reflect occasional consumption or can be representative of their staple diet. Also, this data represents the oldest positive identification of human faecal matter, in a molecular level, using organic geochemical methods.” (Sistiaga, Ainara et. al.).

The El Sidron Neanderthals’ plaque indicate a diet based upon plants including edible mushrooms, pine nuts, forest moss, and poplar.
“The dietary profile in El Sidrón Neanderthals was markedly different from Spy, and containedno sequences matching large herbivores or suggesting high meat consumption. However, reads mapping to edible mushrooms (split gill; Schizophyllum commune), pine nuts (Pinus koraiensis), forest moss (Physcomitrella patens), and poplar (Populus trichocarpa) were identified (Table

1)…Limited zooarchaeological evidence exists for the El Sidrón individuals, and our first genetic description of their diet supports evidence thatNeanderthal groups across Europe used multiple subsistence strategies according to location and food availability[2, 3].” (Weyrich et al. 2017).

“Of course, none of this implies that Neandertals were exclusively carnivorous. Direct evidence of food-plant remains (seeds, fruits, tubers) has been recovered from the Neandertal fossil site of Kebara. Residues of starchy plants have also been detected on Mousterian tools. Plant foods must have provided essential nutrients for Neandertals, and starchy underground storage organs (USOs) and other carbohydrate-rich plant tissues could have made crucial contributions to their high caloric needs. However, the evidence suggests that Neandertals obtained most of their protein, and a lot of their calories as well, by eating meat.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1176).

Analysis of the nitrogen isotopic composition of glutamic acid and phenylalanine in the collagen of Neanderthals from Spy Cave (Belgium) revealed that these Neanderthals relied on plants for up to ~20% of their protein supply. The analysis was performed upon 3 Neanderthal specimens from 2 individuals located in a site where previous evidence from the remains of Neanderthal teeth suggested that these Neanderthals consumed plants. (Naito, Y.I. et. al.).

“An important implication based on the above calculation is that up to ~20% of dietary protein for the Spy Neanderthals could originate from plant foods (Fig. 5)…Nevertheless, provided that assumptions in the present study are correct, the possible dietary plant protein contribution up to ~20% is not trivial at all in terms of nutrition, because wild plants generally contain less protein than animal meat thus leaving the possibility of a much higher contribution of other macro nutrients such as carbohydrates. This is especially the case if their plant protein sources were carbohydrate-rich ones such as underground storage organs (USOs), as suggested by previous studies (Hardy, 2010; Henry et al., 2011). On the other hand, intake of plants via consumption of intestinal organs of herbivorous prey animals could be possible, albeit we have no idea whether these behaviours were unintended or not (Buck and Stringer, 2014).” (Naito, Y.I. et. al. p. 87).

“…the results of this study suggest that Neanderthals in cold climates would have consumed a measurable amount of plants, and it is conceivable that some Neanderthals in more temperate environments could rely even more on plant foods.” (Naito, Y.I. et. al. p. 88).

"Starch grains [not grains as in cereal but rather defined as “particles of starch”] retrieved directly from Neanderthal dental calculus likewise point to widespread use of plant food in MP hominin diet…Likewise, recent macro- and microwear studies of the teeth of Near Eastern MP hominins point to eclectic diets that very likely included a substantial plant food component. Even the nitrogen isotope data extracted from the collagen of European Neanderthals, the data that archaeologists and paleoanthropologists routinely cite nowadays as proof that these "archaic" humans were "top predators," could mask a substantial dietary contribution of plant foods." (Speth, John D. 2013).

"Neandertals who lived in cold, glacial environments of Europe probably did rely heavily, perhaps almost exclusively on meat, as there were few edible plants available in this habitat. But not all Neandertals lived in such extreme conditions. The Ortvale Klde Neandertals almost certainly ate an array of edible plants available in the Southern Caucasus. We don't see this part of the diet because plant remains rarely preserve well in archaeological sites of this antiquity. But there are exceptions. One of these is Kebara Cave in the modern country of Israel…Here archaeologists were lucky. Many plant remains had been charred by fires Neandertals built in the cave, and charred remains have a much better chance of preservation. Archaeologists recovered more than 4,000 charred seeds, and 75 percent of these were legumes (pod plants, mostly peas). There were also pistachios in significant numbers, and a few acorns…It is almost impossible to determine how important these were to the diet of local Neandertals, but it does tell us that when available Neandertals did incorporate plants into their diets." (Wynn, Thomas & Coolidge, Frederick p. 29).

"The existing evidence for Neanderthal plant consumption is richest for Near Eastern sites. Micro- and macro-botanical studies suggest that Levantine Neanderthals made use of several kinds of plants, including date palms, grasses, legumes, acorns, and pistachios…In contrast to the Near Eastern record, there are very few data on the potential importance of plants in the diets of northwestern, “classic” European Neanderthals." (Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. p. 486).

“Sixteen of the 20 phytoliths [from the teeth] are small, decorated spheres or subspherical shapes from the fruits of the date palm (Phoenix spp.)....the fruits of almost every species of date palm are edible, and would have been a nutrient-rich addition to the diet. Only two species of palms are native to the region, with date palm being the single edible one. This evidence, plus the morphological characteristics of the palm phytoliths from the teeth, matching in all respects the fruit of the date palm, strongly suggests that dates were consumed.”(Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 488).

“These sites record some of the extremes of the environments experienced by Neanderthals, from a Mediterranean, although inland and mountainous, environment at Shanidar to a northern, although oceanic, environment at Spy. Our data show that Neanderthals in both environments included a spectrum of plant foods in their diets, including grass seeds (Triticeae cf. Hordeum), dates (Phoenix), legumes (Faboideae), plant underground storage organs, and other yet-unidentified plants, and that several of the consumed plants had been cooked.” (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 489).

“Here we report direct evidence for Neanderthal consumption of a variety of plant foods, in the form of phytoliths and starch grains recovered from dental calculus of Neanderthal skeletons from Shanidar Cave, Iraq, and Spy Cave, Belgium. Some of the plants are typical of recent modern human diets, including date palms (Phoenix spp.), legumes, and grass seeds

(Triticeae), whereas others are known to be edible but are not heavily used today."(Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 486).

"Scientists have also found plaque on the remains of molar teeth containing starch grains - concrete evidence that Neandertals ate plants." (Smithsonian National Museum of Natural History. "Homo Neanderthalensis - How They Survived").

"Plant remains rarely survive at early prehistoric sites and for many years absence of evidence was largely understood to mean evidence of absence. The lack of evidence for plants, together with the large numbers of animal bones found on many sites (Burke 2000), led to a perspective on Neanderthal diet that was dominated by meat. This appeared to be consolidated by stable isotope analyses since the isotope 15N values were consistent with a meat-rich diet (Bocherens 2009; Richards & Trinkaus 2009). The potential contribution of plant foods has not, however, been investigated in stable isotope analyses of Neanderthal diet (Trinkaus in Barras 2012). Furthermore, although this method is widely used as a primary indicator of diet, a proportion of the diet can consist of plants without being visible in the stable isotope signal (Jones 2009)." (Hardy, Karen; Buckley, Stephen; Huffman, Michael p. 873).

In a cave in Israel, we find direct evidence that the Neanderthals were gathering grass seeds:
"Phytolith analysis of sediments from Amud Cave, Israel suggests that Neanderthals were gathering grass seeds as part of their diet (Madella et al., 2002)." (Hardy, Bruce L. p. 665).

"The depositional environments of Amud Cave [Israel] indicate that phytolith assemblages retrieved from the cave's sediments are an integral part of the Middle Palaeolithic sequence. As such, they provide directevidence for plant use. The Amud Neanderthals emphasized both wood and grass exploitation.Ligneous parts of trees and shrubs were used mainly for fuel. Herbaceous plants were used for bedding, possibly fuel, and for food. There is clear and repetitive evidence for the exploitation of mature grass panicles, inferred to have been collected for their seeds." (Madella, Marco et. al. p. 703).

A Note on phytoliths: "...plants can leave some extremely resilient microfossils, of which phytoliths are of particular note. These are biogenic opal silica bodies that originate in the lumen and between the cells of several plant tissues. Owing to their mineral composition, phytoliths are very resistant to decay and may survive in sediments far longer than other plant debris." (Madella, Marco et. al. p. 704).

"We do not argue that the Amud Neanderthals practised intensive grain collection, similar to the Natufians at the close of the Pleistocene (Bar-Yosef & Belfer-Cohen, 1991, 1992). However, the evidence does suggest they were seed gatherers. The absence from Amud Cave of typical artefacts (e.g., sickle blades, grinding and pounding implements), traditionally associated with intensive seed exploitation and/or fully agricultural practices does not necessarily undermine this hypothesis. As Hillman & Davies (1990) discuss at length, the use of sickles is only one of

several optional ways of collecting grass seeds, others being basket- beating (for which, again, there is no archaeological evidence at Amud Cave) or hand-reaping (for which there can be no archaeological evidence in any site)." (Madella, Marco et. al. p. 714).

"The grass family, as a food source, has had an unparalleled calorific impact on the human species, but all our evidence of grass-seed consumption and cereal-based diets has so far come from Homo sapiens. The Amud phytoliths suggest that Neanderthals, too, were experimenting with the family of plants that would ultimately come to dominate the human food chain." (Madella, Marco et. al. p. 716).

"We collected and studied small calculus samples from seven teeth: three from Shanidar III (~46 ka)....Shanidar III, Shanidar Cave, Iraq....A total of 73 starch grains were recovered from the three teeth. Ten of these starch grains exhibited features that allowed us to identify them as grass seed starches from the Triticeae tribe....Starch grains from this tribe, which includes the wild relatives of wheat, barley, and rye...Several features align these starch grains with those from Hordeum (barley). None had the characteristic crater-like dimples that are diagnostic of modern bread wheat (Triticum aestivum) and most other wild wheat species (e.g., Triticum monococcum, Triticum urartu, Triticum vavilovii, and Triticum turgidum)." (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 487).

Underground Storage Organs Intake

Some Direct Evidence for the Possible Consumption of Underground Storage Organs from the analysis of dental calculus of Neanderthals from Belgium and the presence of starch particles on stone tools from Neanderthals living in modern day Crimea (just south of Ukraine) ---
"Spy I and Spy II, Spy Cave, Belgium. We sampled two teeth from both individuals. Over 60 of the 136 starches had a unique, characteristic morphology, with a large ovoid shape, an eccentric hilum with a distinctive crack, distinct lamellae, and a polarization cross with smoothly curving "arms" (Spy I RM1 580c had a large clump of calculus with up to 30 starches embedded, most of which were probably from this type but were too encrusted to identify with confidence). These attributes suggest that the starches are from a USO (Fig. 4 A and B). These starches share many similarities with the starches from the USOs of water lilies, but do not match those from either of the common local water lily species (Nymphaea alba and Nuphar lutea) (Fig. 5). There are several other species of water lily that are native to the study area, but we have not acquired USO samples from them." (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 488).

"The identified plant foods from Shanidar match well with the soil phytoliths and macrobotanical remains found at other Neanderthal sites in the Near East, whereas those from Spy show use of USOs as predicted for European Neanderthals. Neanderthals' consumption of these starchy plant foods does not contradict data from isotope analysis, because nitrogen isotopes record only the consumption of meat and protein-rich plant foods." (Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. p. 489).

“starch grains and plant remains have been found on stone tools from Starosele and Buran Kaya III, Crimea, and provide evidence of starchy storage organs being used as part of the binding in a haft or as food (Hardy et al., 2001). Although specific identification to taxa has not been possible, the results clearly indicate plant exploitation at these sites.” (Hardy, Bruce L. p. 665).

The Potential Importance of Underground Storage Organs in the Northern European Neanderthal Diet during times of extreme COLD:

“Cold, high-latitude environments are typically seen as lacking in plants generally and in plant foods in particular. Plant foods are therefore usually ignored and Neanderthals are increasingly being viewed as top carnivores who derived the vast majority of their diet from meat. Support for this hypothesis comes largely from stable isotope analysis which tracks only the protein portion of the diet. Diets high in lean meat largely fulfill micronutrient needs but can pose a problem at the macronutrient level. Lean meat can compose no more than 35% of dietary energy before a protein ceiling is reached. Exceeding the protein ceiling can have detrimental physiological effects on the individual. Neanderthals would have needed energy from alternative sources, particularly when animals are fat-depleted and lean meat intake is high. Underground storage organs (USOs) of plants offer one such source, concentrating carbohydrates and energy.USOs could also provide an important seasonal energy source since they are at their maximum energy storage in late fall/winter. Although Paleolithic sites are increasingly yielding plant remains, their presence is rare and they are often given only passing mention in Neanderthal dietary reconstructions....Native European wild edible plants with starchy USOs would have been potentially available throughout the Neanderthal range, even during the coldest periods of the Late Pleistocene.” (Hardy, Bruce L. p. 662).

“Although meat foods might have been preponderant in Neanderthal’s diet, particularly during warmer periods, a more abrasive diet, more heavily relying on hard foods, such as roots or bulbs, might have gained in importance during colder periods. These data are not inconsistent with isotopic and zooarchaeological reconstructions suggesting that meat made up the bulk of the diet (at least the protein portion), but it does provide evidence of the potential incorporation of plant foods, particularly USOs, in the diet.” (Hardy, Bruce L. p. 664).

Less Evidence of Plant Use by the Neanderthals than is found with modern humans living on the same land after 20,000 yr. ago:

"…there is some evidence for plant use by Neandertals, more in the Middle East than in Europe, but nothing to the extent shown by modern humans living on the same landscape after 20,000 years ago." (Wynn, Thomas & Coolidge, Frederick p. 86).

However, another very recent study (April 2014) disagrees, present direct evidence of microremains (starch grains and phytoliths) in dental calculus and on stone tools to support the assertion that modern humans and Neanderthals consumed a similarly variety of plant foods:

“Here we present results from the first broad comparison of plant foods in the diets of Neanderthals and early modern humans from several populations in Europe, the Near East, and Africa. Our data comes from the analysis of plant microremains (starch grains and phytoliths) in dental calculus and on stone tools. Our results suggest that both species consumed a similarly wide array of plant foods, including foods that are often considered low-ranked, like underground storage organs and grass seeds. Plants were consumed across the entire range of individuals and sites we examined, and none of the expected predictors of variation (species, geographic region, or associated stone tool technology) had a strong influence on the number of plant species consumed. Our data suggest that Neanderthal dietary ecology was more complex than previously thought.” (Henry, Amanda G.; Brooks, Alison; Piperno, Dolores R. p. 44).

Cooking

The evidence indicates that the Neanderthals cooked their plants ---

“Charred remains of edible plants have also been recovered from Gorham’s Cave, Gibraltar, including wild olives (Olea sp.) and stone pine nut (Pinus pinea) (Barton et al., 1999).” (Hardy, Bruce L. p. 665).

“Many of the grass seed starches showed damage that is a distinctive marker of cooking. Our results indicate that in both warm eastern Mediterranean and cold northwestern European climates, and across their latitudinal range, Neanderthals made use of the diverse plant foods available in their local environment and transformed them into more easily digestible foodstuffs in part through cooking them, suggesting an overall sophistication in Neanderthal dietary regimes.” (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 486).

“Also of considerable interest were the 15 grains that were identical in appearance to cooked starches from the Triticeae....The overall pattern of damage to the starch grains matches most closely with that caused by heating in the presence of water, such as during baking or boiling, rather than “dryer” forms of cooking like parching or popping. The finding of cooked Triticeae starches on the Shanidar teeth reinforces evidence from other studies that suggest that Near Eastern Neanderthals cooked plant foods.” (Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. p. 487).

"Using mass spectrometry, we have identified the ingestion of cooked carbohydrates in the calculus of two adults, one adult in particular having apparently eaten several different carbohydrate-rich foods. The evidence for cooked carbohydrates is confirmed both by the cracked/roasted starch granules observed microscopically and the molecular evidence for cooking and exposure to wood smoke or smoked foodin the form of methyl esters, phenols, and

polynuclear aromatic hydrocarbons (notably pyrene and fluoranthene) found in the dental calculus." (Hardy, Karen et. al. p. 624).

"Cooked plants were eaten by Neanderthals in Western Europe and in Iraq, as evidenced by trapped cooked plant particles that have been found in dental calculus. The extra energy released by cooking must have aided their migrations…" (Friedmann, Theodore; Dunlap, Jay C.; Goodwin, Stephen F. p. 35).

"These sites record some of the extremes of the environments experienced by Neanderthals, from a Mediterranean, although inland and mountainous, environment at Shanidar to a northern, although oceanic, environment at Spy. Our data show that Neanderthals in both environments included a spectrum of plant foods in their diets, including grass seeds (Triticeae cf. Hordeum), dates (Phoenix), legumes (Faboideae), plant underground storage organs, and other yet-unidentified plants, and that several of the consumed plants had been cooked." (Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. p. 489).

Some evidence provided the foundation for a theory that Neanderthals exploited the inner bark of trees (eaten by other primates as well) using a pointed and slightly modified mammoth rib:

“Sandgathe and Hayden (2003) have recently suggested that pointed, modified, mammoth ribs from Salzgitter-Lebenstadt, Germany (Gaudzinski, 1999) were used as bark peelers for the exploitation of the inner bark of trees....the authors also suggest that the pointed ribs could be digging sticks. These suggestions, however, are hypotheses based on analogy with modern ethnographic tools and require further archaeological evidence for confirmation.” (Hardy, Bruce L. p. 665-666).

Genetics (Taste)

Neanderthals had the gene needed for tasting bitterness may add further support the Neanderthal’s consumption of plants:

“The recent identification of the TAS2R38 bitter taste perception gene in a Neanderthal individual from El Sidrón (Lalueza-Fox et al. 2009) is an indicator of an ability to include plants in the diet as bitterness can warn of toxins (Miller 2011). The survival of actual plant remains within Neanderthal sites is rare; however, evidence for edible grass seeds at Amud Cave, Israel (Madella et al. 2002), charred legumes at Kebara Cave, Israel (Lev et al. 2005), and charred nuts at Gorham's Cave, Gibraltar (Barton 2000) suggest these were eaten. Starch granules found embedded in dental calculus from one Neanderthal individual from the site of Shanidar in Iraq and two individuals from Spy in Belgium (Henry et al. 2011) also suggests a plant component in the diet. Furthermore, based on a comparison with the use of similar items from ethnographic contexts, Sandgathe and Hayden (2003) suggest that pointed artefacts of bone and wood found on several Neanderthal sites may have been used to obtain edible inner bark." (Hardy, Karen et. al. p. 618).

Some evidence even suggests that they self-medicated with bitter-tasting plants that have no significant nutritional value but with medicinal compounds that have long been used by humans:

"The presence of pigments and bitter-tasting appetite suppressants (dihydroazulene and chamazulene, and the coumarin, 4-methylherniarin) in the calculus of Young Adult 4 —SD1604 is intriguing. One possible reason for the consumption of bitter-tasting plants with no nutritional value and containing these compounds (such as yarrow and chamomile) would be for self-medication. All the higher primates have a wide and applied knowledge of the edible plants within their environments, and there is an extensive body of evidence demonstrating the complex use of medicinal plants for zoopharmacognosy by animals including all modern higher primates (e.g., Rodriguez and Wrangham 1993; Cousins and Huffman 2002; Huffman 1997, 2003; Singer et al. 2009; Lisonbee et al. 2003; Krief et al. 2005; Huffman and Vitazkova 2007)." (Hardy, Karen et. al. p. 623).

"The starch granules and carbohydrate markers in these samples, the evidence for the azulene and coumarin [medicinal] compounds, the possible evidence for nuts, grasses, and possibly even green vegetables, argue for a broader use of ingested plants than is often suggested by stable isotope analysis." (Hardy, Karen et. al. p. 623)

“In a recent study. Hardy et al. (2012) identified compounds from two non-nutritional plants, yarrow and camomile, in a sample of Neanderthal dental calculus from the northern Spanish site of El Sidrón. Both these plants are bitter tasting and have little nutritional value but are well known for their medicinal qualities. Bitter taste can signal poison. We know that the bitter taste perception gene TAS2R38 was present among the Neanderthals of El Sidrón (Lalueza-Fox et al. 2009), and their selection of yarrow and camomile was hence probably deliberate. With few nutritional benefits, reasons must be sought for why the Neanderthals collected and ingested these plants. They could have consumed them as flavouring, but this presupposes a degree of complexity in cuisine for which there is little evidence. The widespread evidence for animal self-medication, or zoopharmacognosy, however, offers an attractive behavioural context. We propose, indeed, that these plants were selected and ingested deliberately for the purpose of self-medication.” (Hardy, Karen; Buckley, Stephen; Huffman, Michael p. 873).

Other evidence of self-medication was discovered in the plaque of one ill Neanderthal that contained the DNA of a natural antibiotic from the mold Penicillium and that of poplar bark which is a natural source of the aspirin-like painkilling chemical salicylic acid.:
"One of the most surprising finds, however, was in a Neandertal from El Sidrón, who suffered from a dental abscess visible on the jawbone. The plaque showed that he also had an intestinal parasite that causes acute diarrhoea, so clearly he was quite sick. He was eating poplar, which contains the pain killer salicylic acid (the active ingredient of aspirin), and we could also detect a natural antibiotic mould (Penicillium) not seen in the other specimens.” (University of Adelaide 2017).

“Our findings support previous suggestions that El Sidrón 1 may have been self-medicating a dental abscess[8]. This was the only individual whose calculus included sequences corresponding to poplar, which contains the natural pain-killer salicylic acid (the active ingredient in aspirin), and also notably contained sequences of the natural antibiotic producing Penicillium from the moulded herbaceous material. The sample from this individual also included sequences matching the intracellular eukaryotic pathogen microsporidia (Enterocytozoon bieneusi), which causes acute diarrhoea in humans[21], indicating another health issue that potentially required self-medication.” (Weyrich et al. 2017).

"Apparently, Neandertals possessed a good knowledge of medicinal plants and their various anti-inflammatory and pain-relieving properties, and seem to be self-medicating. The use of antibiotics would be very surprising, as this is more than 40,000 years before we developed penicillin. Certainly our findings contrast markedly with the rather simplistic view of our ancient relatives in popular imagination.” (University of Adelaide 2017).

PROCESSING

Plant Food

“The retrieval of several thousand carbonized seeds from the Mousterian layers of Kebara Cave, the majority of which are legumes (Lev, 1993), demonstrates that hard seeds, requiring some form of ‘‘external digestion’’, such as germination, milling, cooking etc., were a part of the diet of the Kebara Neanderthals.” (Madella, Marco et. al. p. 714).

"We note that, as at other Neanderthal sites, there is no evidence of intensification (e.g., stone artifacts specialized for use as grinding implements or storage features) in the use of certain foods as seen in later, Upper Paleolithic, Epipaleolithic, and Natufian preagricultural modern human groups. However, there is clear evidence of cooking in the recovered starch grains, and furthermore, several of the identified plant foods would have required moderate to high levels of preparation, including husking the grass seeds and harvesting the submerged USOs of water lilies. These lines of evidence indicate Neanderthals were investing their time and labor in preparing plant foods in ways that increased their edibility and nutritional quality. It should also be noted that date palms and possibly other unidentified plants have different harvest seasons than barley and legumes, a factor that may suggest that the Shanidar Neanderthals practiced seasonal rounds of collecting and scheduled returns to harvest areas. Overall, these data suggest that Neanderthals were capable of complex food-gathering behaviors that included both hunting of large game animals and the harvesting and processing of plant foods." (Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. p. 489).

Animal Foods

How they obtained the Marrow:

"…the Neandertal hunters used the same procedure to butcher every one…they had a technique in which they removed an end of the metatarsal (one of the long lower rear bones) and popped off the front surface of the bone, revealing an intact marrow cavity for the entire length of the bone." (Wynn, Thomas & Coolidge, Frederick p. 27).

Selected for Bones with the Highest Quality Marrow --- Adult Marrow was preferred & the Marrow of young and sub-adult animals was neglected:
"The Middle Paleolithic site Salzgitter Lebenstedt (northern Germany)…is…dominated by adult reindeer (Rangifer tarandus)…The results indicate autumn hunting of reindeer by Middle Palaeolithic hominids. After the hunt, carcasses were butchered and in subsequent marrow processing of the bones a selection against young and sub-adult animals occurred. Adults were clearly preferred, and from their bones, again, poorer marrow bones were neglected. This focus on primeness of resources has been documented in other domains of Neanderthal behaviour, but Salzgitter Lebenstedt is the best example yet known in terms of systematic and routinized processing of game." (Gaudzinski, Sabine & Roebroeks, Wil p. 497).

"…after the unselective hunt, a selection against subadults and juveniles occurred, and subsequently limb bones were sorted according to marrow quality, with poorer quality bones being discarded, at Salzgitter particularly the metacarpals." (Gaudzinski, Sabine & Roebroeks, Wil p. 512).

"At Les Pradelles, the reindeer carcasses were brought to the site with a preference for the long bones rich in marrow. In the case of communal hunts leading to mass kills, carcasses are subject to standardized treatment resulting in the systematic rejection of certain parts at the butchering site (Wheat, 1972; Binford, 1978; Speth, 1983) whereas small scale hunting results generally in the exploitation of the entire carcass (Bartram, 1993; Bunn, 1993)." (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 55).

"In this context, the great number of prey, the high frequency of cut marks, evidence of standardization and systematization of the meat processing, the selective introduction into the site of the richest elements in marrow and grease, the nature of the occupation and the lack of living structures such as a fire place might be seen as proof of the use of the site as a secondary butchery site and sustain the hypothesis of food storage for a deferred consumption and/or preparation of the animal resources for easier transport toward a base camp (Costamagno et al., 2006).....Furthermore, the discarding of the juvenile bones on site sustains the hypothesis of a selective exploitation of the richest elements." (Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile p. 55).

Evidence that the Neanderthals rendered grease by way of stone-boiling is absent & there is no sign of sophisticated fat and meat storage technology:

"There are few data for any of these uses in Mousterian sites. Grease rendering, which usually involves stone boiling, is easily evidenced by the presence of fire-cracked rock in Upper

Paleolithic and later contexts (e.g., Manneet al. 2005; Nakazawa et al. 2009), but not earlier. Among recent hunter-gatherers different technologies have been employed to extend the storage life of meat, which includes smoking, drying, salting, and mixing other natural preservatives (e.g., berries with tannic acid) with the meat. These actions all serve to severely restrict normal bacterial processes that will cause rapid decay of the meat. Again, there is currently no good evidence that any of these meat preservation techniques, including ones involving fire, were employed during the European Middle Paleolithic, and claims for such behaviors are rare. The thick ash and charcoal deposits associated with fish remains in the Mousterian layers of Grotte XVI, for example, have been proposed as potential evidence for fish smoking, but there is no direct supporting evidence for this (Karkanas et al. 2002; Rigaud et al. 1995)." (DM Sandgathe, HL Dibble, P Goldberg, SP McPherron, A Turq, L Niven, J Hodgkins p. 218).

"Unless Neandertals could eat and digest woody plant parts, they must have been subject to the same prolonged seasonal droughts in carbohydrate. Modern hunter-gatherers inhabiting these regions typically build reasonably sophisticated storage containers for their meat and fat stores. Such storage structures are not reported for Neandertal sites. Modern hunter-gatherers also invest labor and technology in rendering grease and fat from the carcasses and bones of animals, typically through boiling technologies. Before ceramics, those tasks involved the use of boiling stones and boiling containers made of skins, resulting in vast numbers of fire-cracked rock and hearths demarcated with large stones. However, fire-cracked rock and stone-lined hearths only became common in the Upper Paleolithic. This suggests that Neandertals lacked sophisticated meat and fat storage technology, as well as productive fat rendering technology. At a minimum, the lack of storage capabilities and a lower caloric yield per carcass would have forced Neandertals to use larger foraging ranges to increase the likelihood of successful encounters with prey. Thus the differences that separate Middle Paleolithic and Middle Stone Age hominids from modern people may not reside in scavenging vs. hunting or the types of animals that they pursued. Differences in the effectiveness of carcass use and processing, with their direct implications for caloric yield, may be more important." (Marean, Curtis W. & Assefa, Zelalem p. 35-36).

"No fire-cracked rocks have been found at any of the Mousterian sites discussed in this paper…It is thus difficult to consider the possibility of hot-rock bone-boiling technologies at these three sites." (Costamagno, Sandrine p. 220).

Lacking a hot-rock technology for obtaining extra fat from bones, one scientist has proposed the hypothesis that the Neanderthals crushed and swallowed the marrow rich ends of bones:

"…Maasai peoples may entirely consume smashed bones. Given the need for fat in cold, temperate, subarctic, and arctic environments, Marean (2005) proposed the hypothesis that Neanderthals lacking a hot-rock technology swallowed crushed cancellous bones…Did the resulting 'bony paste' have the same capacities for storage as the bone grease rendered by boiling?" (Costamagno, Sandrine p. 222).

At two sites in France, the long bone epiphyses (ends of the bones richest in marrow) were absent relative to the shafts of the long bones, leading scientists to suggest that the ends were missing due to their use for bone grease rendering. While this hypothesis appears to be supported, there is still a complete lack of evidence from other Neanderthal sites of such activities. All together, there is very little evidence for advanced fat-rendering techniques among Neanderthals:

"The scarcity of some skeletal parts suggest that the red deer were hunted by Neanderthals who brought them into the cave in portions, which they then defleshed, as is indicated by the abundance of cut marks. The absence of complete long bones, the presence of impact points on the shaft fragments, and the fracture edges indicating that mostly fresh bone was fractured, are all evidence that long bones were fragmented to extract their marrow. The red deer remains are also characterized by a clear under-representation of epiphysis [the rounded ends of longs bones] portions relative to long bone shafts." (Costamagno, Sandrine p. 215-217).
....."An under-representation of long bone epiphyses relative to shaft portions may thus provide an archaeological signature for bone grease rendering. However, numerous other taphonomic processes can also lead to a scarcity of epiphyses, including post-depositional processes, carnivore gnawing, or the use of bone as fuel." (Costamagno, Sandrine 210 -211)....."In all of these examples, with the exception of the Koriak, who sometimes used shaft fragments…only cancellous [i.e. ends of bones with small cavities filled with marrow] portions are processed for bone grease rendering." (Costamagno, Sandrine p. 209-210).
Why were the epiphyses [rounded ends of long bones known for their high fat content] missing from the mix of bones? These parts are preferred by carnivores but do not appear to have been exploited by carnivores in this case: "The extreme rarity of red deer epiphyses raises interesting questions. Numerous studies have shown that when carnivores had access to carcasses already exploited by humans, they preferentially consumed the epiphyseal fragments due to their high fat content…At Noisetier Cave, tooth marks are present on less than 3% of the red deer remains. This percentage is well below the values recorded for modern reference collections of carcasses exploited by humans and then scavenged by carnivores." (Costamagno, Sandrine p. 218).

Nor is it likely to be the result of natural destructive forces, and thus may be from bone grease rendering: “The Mousterian site of Les Pradelles shows the same pattern as that of Noisetier Cave…As at Noisetier Cave, long bone epiphyses are poorly represented. Shaft fragments represent 95% of the long bone sample and epiphysis fragments are on average less than 2 cm long. The under-representation of long bone epiphyses cannot be linked to carnivore actions or to density-mediated destruction since the bones are very well preserved. No burned bones have been found at Les Pradelles. Therefore, as at Noisetier Cave, the underrepresentation of reindeer epiphyses may be attributable to bone grease rendering." (Costamagno, Sandrine p. 220).

However, evidence for such activities as bone grease rendering is thus far not widely found:

"Not all Mousterian sites are characterized by this pattern, however, as is shown at the site of Payre, level Fa, which has a high ratio of long bone epiphyses." (Costamagno, Sandrine p. 220).

Also a noted email response from Curtis W. Marean on the current weak level of evidence for bone grease rendering by Neanderthals:

"Hi Rebecca,

I don't think there has been any advance on this – there is still little evidence for advanced fat-rendering techniques among Neanderthals.

Best,

Curtis"

(Marean, Curtis W. "Neanderthal Meat & Fat Storage & Fat Rendering." Reply Message to Rebecca Cox. 11 Feb 2014. E-mail.).

Modern Humans vs. Neanderthals -- The Controversy over Differences in Diet

"Several authors argue that Neanderthals were unable to acquire as many calories from the same environments as were modern humans and were thus easily outcompeted. These views are supported by data suggesting that Neanderthals focused primarily on large game and for the most part eschewed foods more common in modern human diets, such as marine resources, small, hard-to-catch animals, and protein-rich plant foods like nuts. Other evidence suggests that Neanderthal foraging patterns were much like those of modern humans, including small game, marine resources, plant foods, similar use of fire, some cooking, and other food processing, and that these behaviors may have extended back in time to the Middle Pleistocene." (Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. p. 486).

"Fossil remains at that site indicate that hunting was, in fact, pretty much all Neanderthals did to acquire food in the extreme cold of the last glacial period. Pettit speculates whether their emphasis on meat, to the exclusion of more plant food, was one cause of their extinction…(There is always a danger of generalizing about the Neanderthals, though. They occupied a vast range of environments and habitats. Earlier studies in the Middle East found remains of berries, nuts, and other plants at Neanderthal sites.)" (Hart, Donna & Sussman, Robert W. p. 230).

Neandertal vs. Human Diet from Isotopes: "Presented with the same geographical region and available resources, Neandertals relied on large herbivores for their dietary protein, and only rarely, if at all, used aquatic resources. The first modern humans in Europe used a broader dietary base than the Neandertals, in some cases supplementing their diet of herbivore protein

with substantial amounts of aquatic foods. We are still in the early stages of this analysis, but it is possible that this adaptation of modern humans to use a broader range of foods, especially those not used by Neandertals, gave modern humans a competitive advantage over the successful, but more economically conservative, Neandertals." (Roebroeks, Wil ed. p. 231).

"O'Connell (2006) thinks that this specialized subsistence pattern placed Neandertals at a disadvantage in competing with modern humans, who were able to make use of a wide range of food sources." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1176-1177).

Contradicting Evidence --- the other point of view that sees the subsistence patterns, hunting, butchering, and also choice of prey by Neanderthals and modern humans to be similar or even identical:

"In Gibraltar [spain], Neanderthals and modern humans apparently shared similar or identical 'modern' subsistence practices at approximately 28,000 years ago, yet Neanderthals were clearly outside of the range of morphological and genetic variability of modern humans." (Shipman, Pat p. 14242).

"Grayson & Delpech showed that Neanderthals & Upper Paleolithic humans did not show significant differences in hunting and butchering behavior in the material studied. Similarly, we have observed that the human occupation levels at Gorham's Cave, first occupied by Neanderthals and then by Upper Paleolithic humans, do not show obvious differences in faunal composition." (Stringer, C.B. et. al. p. 14323).

Side Notes: "For twenty-five thousand years, nearly three times longer than we have been recording our own history, Homo sapiens and Neanderthals shared the same part of the world." (Walter, Chip p. 113).

And we know they came face to face: "Paleontologist Fernando Ramirez Rozzi found something rare in the human fossil world, a cave called Les Rois in southwestern France that housed the bones of a modern human and a Neanderthal child lying together, positive proof that the two species came face-to-face. Unfortunately the jawbone of the child shows the same sort of markings paleontologists see on the bones of butchered reindeer skulls. The unappetizing conclusion is the child was made a meal of. Hints that other Neanderthals met a similar, cannibalized fate have been found at a site called Moula-Guercy near France's Rhone River. Except in this case those who dined on their fellow humans were themselves Neanderthals. Perhaps it was a violent ritual, or the spoils of war, or maybe some who had died of starvation became the sustenance for those who survived." (Walter, Chip p. 117).

Neanderthal DNA

“They [Neanderthals] are very closely related to modern humans,[5][6] differing in DNA by only 0.12%.”(Wikipedia, the Free Online Encyclopedia “Neanderthals” Accessed 5/23/2014).

"Paabo's analysis was also able to identify seventy-eight genes found in the modern genome that were not found in the three Neandertal women. It is important to keep this in perspective; the Neandertal and modern genomes were 99.84 percent identical." (Wynn, Thomas & Coolidge, Frederick p. 7).

"When we compare the mtDNA recovered from Neandertal skeletons to that of modern people, we find about three times as many differences (twenty-seven mutations versus eight) as we find when we compare the two most different modern people with one another. This tells us a couple of interesting things. First, Neandertals were at least three times more different from us, in terms of mtDNA, than any of us is from any other modern person. Second, if we apply a rate of change - that is, a rate at which mutations occur - we can estimate how long ago we and Neandertals separated…most paleoanthropologists are comfortable with a rate of change that places the split about 500,000 years ago." (Wynn, Thomas & Coolidge, Frederick p. 6).

“Homo sapiens and Neanderthals share a common ancestor that probably lived in Africa more than half a million years ago. The ancestors of Neanderthals were the first to move to Europe and Asia while the modern-human lineage stayed in Africa. But after modern humans began to leave Africa less than 100,000 years ago, they interbred with the Neanderthals who had settled on a range stretching from Western Europe to Siberia.” (Callaway, Ewen).

“In the past few years, studies by groups including Reich’s have revealed that present-day people of non-African ancestry trace an average of about 2 percent of their genomes to Neanderthals — a legacy of interbreeding between humans and Neanderthals that the team previously showed occurred between 40,000 to 80,000 years ago. (Indigenous Africans have little or no Neanderthal DNA because their ancestors did not breed with Neanderthals, who lived in Europe and Asia.)” (Dutchen, Stephanie).

“Genomic studies have shown that Neanderthals interbred with modern humans, and that non-Africans today are the products of this mixture.” (Sankararaman, Siram et. al.).

“The Neanderthal contributions are peppered across the genome, and different people have different Neanderthal genes.” (Callaway, Ewen).

“Remnants of Neanderthal DNA in modern humans are associated with genes affecting type 2 diabetes, Crohn’s disease, lupus, biliary cirrhosis, and smoking behavior. They also concentrate in genes that influence skin and hair characteristics....Neanderthal ancestry is increased in genes affecting keratin filaments. This fibrous protein lends toughness to skin, hair, and nails and can be beneficial in colder environments by providing thicker insulation, said Reich. “It’s tempting to think that Neanderthals were already adapted to the non-African environment and provided this genetic benefit to humans,” he speculated.

The researchers also showed that nine previously identified human genetic variants known to be associated with specific traits likely came from Neanderthals. These variants affect diseases related to immune function and also some behaviors, such as the ability to stop smoking. The team expects that more variants will be found to have Neanderthal origins." (Dutchen, Stephanie).

"Sex with Neanderthals had its ups and its downs. Cross-breeding may have given modern humans genes useful for coping with climates colder than Africa's, but the hybrid offspring probably suffered from significant fertility problems." (Callaway, Ewen).

"...genes involved in keratin filament formation [i.e. for skin & hair] and some other biological pathways are significantly enriched in Neanderthal ancestry in European populations, east-Asian populations, or both. Thus, Neanderthal alleles that affect skin and hair may have helped modern humans to adapt to non-African environments." (Sankararaman, Sriram et. al.).

"Nevertheless, the Neanderthals were also a probable source for at least a few genetic variations that were adaptive for their human descendants. Neanderthal DNA sequences are found in regions of the genome that have been linked to the regulation of skin pigmentation. The acquisition of these variants by mating with the Neanderthals may have proven to be a rapid way for humans to adapt to local conditions." (University of Washington).

"…in 2010 a scientific consortium headed by the Max Planck Institute for Evolutionary Anthropology completed its historic analysis of the Neanderthal genome…The analyzed DNA was extracted from three Neanderthal bones discovered at the Vindija Cave in Croatia not far from the Adriatic seacoast…the team compared the Neanderthal DNA with the genomes of five people of different lineages from around the world-- French, Han Chinese, Papuans from New Guinea, and the Yoruba and San people of Africa…all the genetic samples taken, except for the Yoruba and San people of Africa, contained 1 to 4 percent Neanderthal DNA. In other words, most of the human race from Europe to the islands of Southeast Asia (and probably farther) is part Neanderthal! That Africans seem not to share any Neanderthal blood indicates that these two families mated after the wave of Homo sapiens departed Africa, but before their descendants headed into Europe and Asia. According to the researchers, this would have been somewhere between eighty thousand and fifty thousand years ago." (Walter, Chip p. 121-122).

"In 2010 Svente Paabo and fifty-five colleagues of the Neanderthal Genome Analysis Consortium published the first draft of their attempt to document the entire Neanderthal genome ("genetic" DNA in the cell nucleus). They based their analysis on archaic DNA recovered from the bones of three Neandertal women who died in Croatia about 45,000 years ago, which they compared to the DNA of modern people living in Europe, Asia, and Africa. The results were a bit of a surprise. The primary result demonstrated that 1 to 4 percent of the genes in modern Asians and Europeans had a Neanderthal origin. The figure of 1 to 4 percent may not sound like much, but it confirms a suspicion held by many paleoanthropologists that Neandertals and modern humans could, and did, interbreed." (Wynn, Thomas & Coolidge, Frederick p. 7).

"Two other results were equally interesting: modern Africans have no Neanderthal genes in their genome, and the Asian genome had just as many Neandertal genes as the European genome. The most likely explanation for this state of affairs is that the interbreeding occurred after modern humans had migrated out of Africa but before they dispersed into Europe and Asia…What is important is that there was gene flow between Neandertals and our ancestors prior to our expansion into Europe and East Asia. But this gene flow, the term geneticists use for the transfer of genes from one population to another, was one-way; no specifically modern human genes were identified in the Neandertal genome." (Wynn, Thomas & Coolidge, Frederick p. 7).

Oral microbiota shared between Neanderthals and modern humans long after their split may suggest friendly interactions between these two species.
A certain bacterial strain of Methanobrevibacter specific to Neanderthals was found and was estimated to have diverged from the Methanobrevibacter strain carried by modern humans between 112,000-143,000 years ago, long after the Neanderthals and modern human lineages are believed to have split. This may indicate that the two species interacted in ways such as kissing or sexual behavior that would have allowed for transmission of the bacteria. Though, it is also possible that the two lineages both obtained from the bacteria from a common food contaminated with the strain and consumed by both, or from contaminated water, or from the environment in general.
“Date estimates using a strict molecular clock place the divergence between the M. oralis strains of Neanderthals and modern humans between 112–143 ka (95% highest posterior density interval; mean date of 126 ka) (Fig. 3b; see Supplementary Information). As this is long after the genomic divergence of Neanderthals and modern humans (450–750 ka)29, it appears that commensal microbial species were transferred between the two hosts during subsequent interactions, potentially in the Near East30.” (Weyrich et al. 2017).

“The Neandertal plaque allowed reconstruction of the oldest microbial genome yet sequenced -- Methanobrevibacter oralis, a commensal that can be associated with gum disease. Remarkably, the genome sequence suggests Neandertals and humans were swapping pathogens as recently as 180,000 years ago, long after the divergence of the two species.” (University of Adelaide 2017).

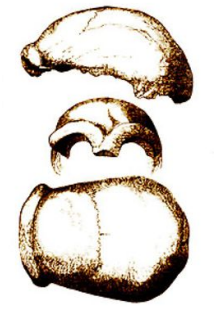
Fossils
(short list of predominant, more informative fossils)

“they [Neanderthals] are represented by relatively abundant fossils from virtually all parts of the skeleton.” (Klein, Richard G. p. 445).

The First Neanderthals to be discovered:
“Fossils of Neanderthals were first found in the eighteenth century prior to Charles Darwin's 1859 publication of The Origin of Species, with discoveries at Engis, Belgium in 1829, at Forbes

Quarry, Gibraltar in 1848, and most notably a discovery in 1856 in Neander Valley in Germany, which was published in 1857. However, the earlier findings prior to 1856 were not recognized as belonging to archaic forms, but were widely misinterpreted as skeletons of modern humans with deformities or disease (Gould 1990).” (New World Encyclopedia contributors, "Neanderthal." New World Encyclopedia).

Neanderthal 1



(Skullcap found of Neanderthal 1,
Photo Courtesy of Wikimedia Commons -- Public Domain).

Nickname: Neanderthal 1
Site: Kleine Feldhofer Grotte - a cave in the Neandertal Valley in northern Germany
Date of Discovery: 1856
Age: about 40,000 years old

“Feldhofer 1, Neanderthal 1 is the common name for the initial 40,000-year-old Neanderthal specimen found in Kleine Feldhofer Grotte in August 1856. It represents the beginning of paleoanthropology as a scientific discipline. The discovery was made in Feldhofer grotto in a limestone quarry located in Neanderthal, Germany. Neanderthal 1 consisted of a skull cap, two femora, the three right arm bones, two of the left arm bones, ilium, and fragments of a scapula and ribs. The fossils were given by quarry workers to a local teacher and amateur naturalist, Johann Carl Fuhlrott. The description of the remains was determined by anatomist Hermann Schaffhausen.” (Wikipedia, the Free Online Encyclopedia “Neanderthal 1” Accessed 5/25/2014 http://en.wikipedia.org/wiki/Neanderthal_1).

“This discovery of a skullcap and partial skeleton in a cave in the Neander Valley (near Dusseldorf) was the first recognized fossil human form, although the prior two discoveries were subsequently recognized as the first early human fossils found (Smithsonian 2014b)....The workers who recovered this material originally thought it to be the remains of a bear.” (New World Encyclopedia contributors, "Neanderthal." New World Encyclopedia).

"The first Neandertal fossils to attract serious attention were found in 1856…pronounced that they belonged to a savage member of a 'very ancient human race.'…reckoned…these were bones of a rickets-ridden, cave-dwelling hermit…the prototypical caricature of the caveman that most of us still carry around in our minds - dim-witted, brutish, and slow…" (Walter, Chip p. 102-104).

"The idea that the bones were those of a distinct type of human, previously unknown, was first proposed by English geologist William King, the first scientist to use the name Homo neanderthalensis (King 1864)."

“In 1856 a discovery was made in Germany that finally sparked the recognition that these were, in fact, not just strange looking modern people....Thinking that they were from a bear, the quarrymen gave them to a local school teacher and amateur naturalist, Johan Karl Fuhlrott. He recognized them as being human but somewhat different from those of modern Europeans. When several leading paleontologists and medical pathologists in Germany became aware of the fossils, a disagreement developed about who the "Neandertal Man" might have been. It was suggested that he had been an old Roman, a Dutchman, and even a Central Asian soldier in the service of the Russian czar during the Napoleonic wars of the early 19th century. The reality that these bones were from an earlier variety or species of human was not yet conceivable to most of the scientific world in the 1850's.

What finally convinced the scientific community that Neandertals were very ancient Europeans was a combination of additional fossil discoveries and new perspectives that largely began with the publication of Charles Darwin's On the Origin of Species in 1859. This seminal work in biology popularized the idea that species of living things evolve over time as a result of natural selection. Subsequently, it was not a major leap in understanding to realize that humans also must have evolved from earlier forms. In fact, Darwin proposed just that in his 1871 influential publication The Descent of Man, and Selection in Relation to Sex.” (O’Neil, Dennis).

La Chapelle-aux-Saints

Image Credit: Tyler Evans

Nickname: The Old Man of La Chapelle
Site: La Chapelle-aux-Saints, France
Date of discovery: 1908
Age: about 60,000 years old

“Discovered in 1908, the skeleton of “the old man of La Chapelle” was the first relatively complete skeleton of a Neandertal individual that scientist had ever found.” (Smithsonian National Museum of Natural History. “La Chapelle-aux-Saints”).

“Because he suffered from a degenerative joint disease, this skeleton was originally reconstructed as stooped over. This slouching posture came to exemplify our image of

Neanderthals, but it was later found that this reconstruction was incorrect." (Smithsonian National Museum of Natural History. "Homo Neanderthalensis - Key Fossils.").

"The most controversial one was excavated in 1908 at La Chapelle-aux-Saints in southwestern France. This is a nearly complete skeleton of a man who would have been elderly by Neandertal standards. The bones were analyzed between 1911 and 1913 by the noted French paleontologist, Marcellin Boule. Unfortunately, Boule's prejudices got in the way of scientific objectivity. He described the La Chapelle-aux-Saints man, and subsequently all Neandertals, as dull-witted, brutish, ape-like creatures who walked hunched over with a shuffling gait. Unfortunately, this mistaken view was universally accepted by paleoanthropologists for decades. It also became the source of the popular images of dim-witted cavemen that still appear in cartoons and movies....After reanalysis of the La Chapelle-aux-Saints skeleton in the 1950's, it became clear that a serious mistake had been made. This had been an atypical Neandertal. He was at least 40 years old with a somewhat hunched over posture resulting from severe arthritis in his spine. There was a bowing of his legs that may have resulted from rickets disease in childhood. He had lost most of his teeth and part of his jaw resulting in a disharmonic looking face. Despite these deforming infirmities, it is now clear that the La Chapelle-aux-Saints man was much more like us in appearance, intelligence, and physical ability than had been believed by Marcellin Boule." (O'Neil, Dennis).

La Ferrassie

Image Credit: Copyright Smithsonian Institution

Site: La Ferrassie Cave, France
Date of discovery: 1909
Age: Between 70,000 and 50,000 years old

"This is the largest and most complete Neanderthal skull ever found. It was discovered in 1909, along with several other Neanderthal fossils, in the rock shelter of La Ferrassie in southwestern France. Neanderthals used this shelter thousands of years before the arrival of Homo sapiens in Europe." (Smithsonian National Museum of Natural History. "Homo Neanderthalensis - Key Fossils").

"...produced the remains of an adult male and an adult female, providing scientists with the first evidence of sexual dimorphism in Neanderthals...A total of eight Neanderthal individuals -- including adults, children, infants, and two fetuses -- were found intentionally buried at La Ferrassie. One of the most important individuals found at La Ferrassie is La Ferrassie 1, the skeleton of an adult male. His skull, the largest and most complete Neandertal skull ever found (in 1909), has many of the typical Neandertal traits such as the low, sloping forehead and large nasal opening...La Ferrassie 1 is considered by many scientists to exhibit the 'classic' example of Neandertal anatomy. His leg and feet bones proved without a doubt that Neanderthals walked upright and with a gait very similar to modern humans."(Smithsonian National Museum of Natural History. "La Ferrassie.").

Shanidar 1

Image Credit: Chip Clark, Smithsonian Institute

Nickname: Nandy
Site: Shanidar, Iraq
Age: Between 45,000 and 35,000 years old

"At a young age, this Neanderthal experienced a crushing blow to this head. It damaged his left eye socket and the brain area that controlled the right side of his body, leading to a withered right arm. Nevertheless, he lived until 35-45 years of age. His group must have looked over him." (Smithsonian National Museum of Natural History. "Homo Neanderthalensis.").

"The blow damaged the left eye (possibly blinding him)...leading to a withered right arm and possible paralysis that also crippled his right leg...scientists estimate he lived until 35-45 years of age. He would have been considered old to another Neandertal, and he would probably not have been able to survive without the care of his social group." (Smithsonian National Museum of Natural History. "Shanidar 1").

The Neanderthal Brain

Brain Size

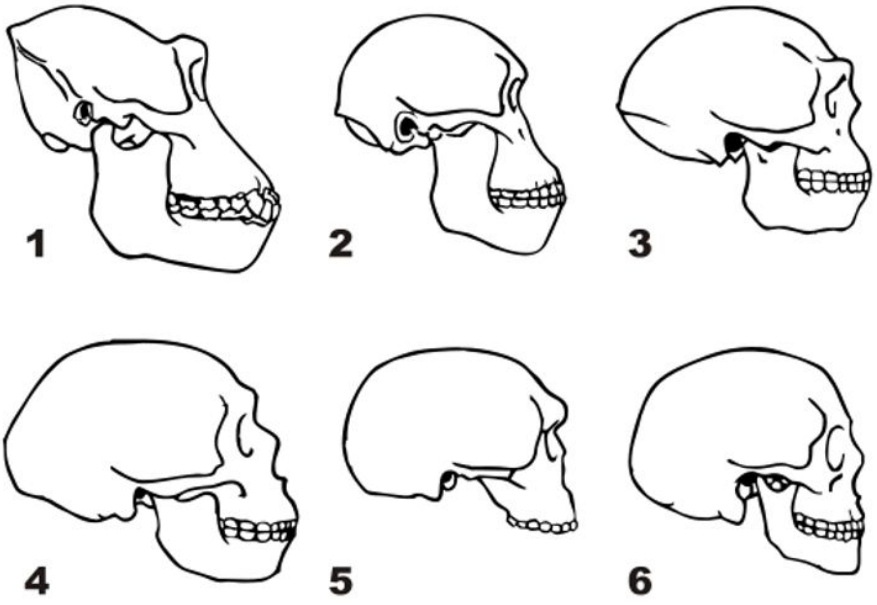
“The braincases of Neandertals reflect the continuing enlargement of the brain during the late Middle and early Late Pleistocene. Neandertal brains were as large as those of living humans.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1053).

“...ranging from 1,245 to 1,740 cc and averaging about 1,435 cc (this compares with an average of about 1,560 cc in the earliest anatomically modern Europeans and of about 1,340 cc in living people)...” (Klein, Richard G. p. 445).

“The large average size of the Neanderthal brain is the culmination of a tendency toward increasing size throughout the course of human evolution, and it almost certainly means that the Neanderthals were more intelligent than any of their smaller-brained antecedents...Brain expansion beyond the average for living humans is difficult to explain, but it may simply reflect the greater metabolic efficiency of large brains in cold climates, the large amount of lean body mass (striated muscle) in Neanderthals, or both. Among living people, the largest average brain size, actually equal or larger than that in Neanderthals, occurs in Inuit, who live in very cold conditions and who also tend to possess a large quantity of lean body mass.” (Klein, Richard G. p. 459-460).

“Neandertal brain size, as measured by cranial capacity, is often said to be greater than that of modern humans. But...When body size is taken into account, there is no evidence that Neandertal brains differ significantly in size from those of modern humans...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1084-1085).

Craniums of Homo:
1. Gorilla 2. Australopithecus 3. Homo erectus 4. Neanderthal (La Chapelle aux Saints) 5. Steinheim Skull 6. Caucasoid



(Wikipedia, the Free Online Encyclopedia “Neanderthal” Accessed 5/23/2014).

Encephalization

“Similarity in size does not guarantee similarity in structure. The Neandertal brain was somewhat different in shape and proportions from the brains of modern humans, and some have speculated that there may have been corresponding differences between the two groups in neural organization and mental abilities...R. Holloway, who has studied more fossil endocasts than anyone else and has done everything possible to draw inferences from the anatomy of the skull to the anatomy of the brain, finds nothing in Neandertal endocasts to suggest significant differences from modern humans in neural structure or function...Neandertals exhibit a modern human pattern of hemispheric asymmetry. They show a humanlike development of Broca’s and Wernicke’s areas. Although these assessments of surface topography tell us little about the internal organization of the brain, the available indicators provide no real support for the claim that Neandertal brains were functionally different from our own.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1084-1085).

“With an average cranial capacity of 1600 cc,[19] Neanderthal's cranial capacity is notably larger than the 1400 cc average for modern humans, indicating that their brain size was larger. However, due to larger body size, Neanderthals are less encephalized.” (Wikipedia, the Free Online Encyclopedia “Neanderthal” Accessed 5/23/2014).

The idea that Neanderthals were less encephalized & that this may be informative of their level of intelligence is debated:

“Results confirm that relative ECV [Endocranial Volume]/brain size in Neandertals was not significantly depressed relative to recent and fossil H. sapiens and this is consistent with a

substantial body of data from living humans dismissing any simple correspondence of relative brain size with intelligence and, by extension, evolutionary success." (Gallagher, Andrew).

Differences in the volume of specific areas of the Neanderthal brain may hint at, but does not provide any conclusive evidence of a difference in behavior or cognitive abilities from modern humans...---

"Neandertal brains were longer and broader than ours, and were broadest in the middle when viewed from behind…Their frontal lobes had about the same volume as ours…The frontal lobes…control many of the so-called higher brain functions such as reasoning, planning, and emotional control…The volume of Neandertals' parietal lobes was smaller than ours. [However]…At our current state of understanding we just cannot take this bit of data - Neandertals having smaller parietal lobes - and come up with even a single likely difference in behavior." (Wynn, Thomas & Coolidge, Frederick p. 14).

"One possible significant difference noted by Holloway is that Neandertal brains appear to have been somewhat larger than those of more recent humans in the anterior part of the occipitomastoid area of the cerebral cortex...it may signal an expansion of the primary visual striate cortex in Neandertals - which might indicate that they possessed enhanced visual and spacial abilities." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1085).

Linguistics

"Could Neanderthals speak?"
Clues from Skeletal Anatomy, in particular the hyoid bone ---

"As far as is presently known, no aspect of skeletal anatomy can tell us whether Neandertals - or any other ancient humans - had human-like capacities for making and using language." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1191).

However - the vocal tract contains one bone, the hyoid bone, that has been preserved in the fossil record - "The hyoid undoubtedly plays an active role in speech and is indicative of the state of the vocal tract. As the vocal tract's only ossified element, it is the only part likely to be preserved in the fossil record…It provides support for the larynx and anchorage for the tongue and other muscles required for speaking." (D'Anastasio, Ruggero; Wroe, Stephen; Tuniz, Claudio; Mancini, Lucia; Cesana, Deneb T. et. al.).

"By analyzing the mechanical behavior of the fossilized bone with micro x-ray imaging, we were able to build models of the hyoid that included the intricate internal structure of the bone…Our comparisons showed that in terms of mechanical behavior, the Neandertal hyoid was basically indistinguishable from our own, strongly suggesting that this key part of the vocal tract was used in the same way." (University of New England).

"Here we show that the Neanderthal and modern human hyoids also present very similar internal architectures and micro-biomechanical behaviors…our findings are consistent with a capacity for speech in the Neanderthals."(D'Anastasio, Ruggero; Wroe, Stephen; Tuniz, Claudio; Mancini, Lucia; Cesana, Deneb T. et. al.).

“We conclude that the presence of modern human-like histological features and micro-biomechanical behavior in the Kebara 2 hyoid indicates that this bone not only resembled that of a modern human, but that it was used in very similar ways…These findings are consistent with the suggestion that the Kebara 2 Neanderthal practiced speech, although they do not prove that this was so.” (D'Anastasio, Ruggero; Wroe, Stephen; Tuniz, Claudio; Mancini, Lucia; Cesana, Deneb T. et. al.).

Side note: This study is suggestive but does not present any firm conclusions as to whether or not the Neanderthals had speech and if it was similar to modern human speech abilities.

Neanderthals share a form of a gene known as the FOXP2 gene with modern humans, a gene proven to be key to speech development and thought to have been selected for as an adaptation to language. This, of course, offers another piece of evidence that supports the idea that Neanderthals possessed an ability for language ---

“The language abilities of Neandertals, and thus their human status, have been debated ever since the first studies of Neandertal remains in the mid-19th century. Some researchers have argued that Neandertals were unable to produce the full range of sounds needed for efficient encoding of speech. Others contend that fully modern language emerged only about 50 Kya, possibly as a single genetic mutation (Klein & Edgar 2002). Although few have claimed that Neandertals lacked language altogether, it is often asserted that whatever speech capacities they had must have been subhuman. However, the preponderance of current evidence suggests otherwise. For example, a recent analysis of Neandertal DNA recovered from El Sidrón Cave in Northern Spain shows that Neandertals shared the uniquely derived human form of the FOXP2 gene (Krause et. al. 2007a). This gene encodes a transcription factor protein that is extremely conservative in mammals differing in only one amino acid between chimpanzees and mice. Modern humans, however, show two additional amino acid substitutions not shared with other mammals. Because people carrying mutations in this gene suffer impairments in various aspects of speech production and grammatical ability, it has been suggested that the distinctive human form of FOXP2 was selected for as an adaptation to language. Its presence in both Neandertals and modern humans indicates that the adaptation took place before the two groups diverged. While this does not prove that Neandertals had fully developed modern human language capacities, it is one strong piece of evidence that they did...For now, it is sufficient to note that Neandertals were almost certainly ‘talking apes,’ and probably not the first ones.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1017-1018).

"Both we and Neanderthals carry the FOXP2 gene in our chromosomes, a snippet of DNA key to the development of speech…" (Walter, Chip p. 109).

"A more provocative gene identified for Neandertals is known as FOXP2. A variant of the FOXP2 gene is known to cause a speech impediment and difficulties in learning and using certain kinds of grammar. Neandertals have the normal variety. Does this mean that Neandertals had modern speech, just like you and me? Perhaps, but not necessarily. FOXP2 is not a gene for language or speech; rather it is a gene that is involved in modern speech. There are undoubtedly many other genes involved in modern spoken language that have not been identified. Neandertals may or may not have had them. But their possession of FOXP2 is certainly provocative." (Wynn, Thomas & Coolidge, Frederick p. 8).

To summarize - "...the fact that Neandertals share the uniquely human FOXP2 sequence strongly suggests that they also shared a human capacity for language...Krause et. al. (2007a) conclude that the FOXP2 mutations shared by modern humans and Neandertals were probably fixed in their last common ancestor before the presumed split between the two populations, which they date to between 300 and 400 KYA. But there are other possibilities. For example, Neandertals might have acquired the modern FOXP2 variant through interbreeding with their modern human contemporaries." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1168).

"If Neanderthals did speak, what did Neanderthal speech sound like?"

"...Neanderthals could not make the sounds of modern humans; they may have had speech but they did not speak as we do. Two anatomical circumstances determine the sounds that are possible from the modern human throat (1) whether the base of the skull is flat or angled, and (2) the position of the larynx (the resonating chamber or voice box) that holds the vocal cords…Chimpanzees have flatter skull bases than do humans; they also have larynges sitting much higher in their throats than modern humans do…Neanderthals had a skull-base angle intermediate between chimpanzees and modern humans; they may not have been able to make some of the vowel sounds that we can due to the higher position of their larynx."(Hart, Donna & Sussman, Robert W. p. 185-186).

SIDE NOTE on Homo Erectus & Language Abilities: "…Homo erectus…had an angled skull base more like modern humans. Who knows what their capacity for linguistics might have been." (Hart, Donna & Sussman, Robert W. p. 186).

"…we cannot describe how Neandertal speech or hearing might have differed from ours. Given the differences between Neandertal faces and ours, we suspect that Neandertal voices sounded a bit different, and the range of consonants and vowels they could generate might have been different, but nothing we know about Neandertal anatomy would seriously limit their capacity for speech…We know that modern brains control speech production using a region of the lower left frontal lobe known as Broca's area and that, compared to other primates, our Broca's area is enlarged…In nonhuman primates this area of the brain controls guided reaching with the hands, the kind of motor action that is also used to manipulate tools. And the first evidence for expanded Broca's area in fossil hominin endocasts coincides with the first appearance of stone tools. So was it speech or tool use? We don't know. On the positive side, evidence

conclusively identifies an expanded Broca's area for all post-Homo erectus hominids, including Neandertals. This suggests that Neandertals had speech, but does not tell us how similar it might have been to ours." (Wynn, Thomas & Coolidge, Frederick p. 128).

"What would the Neanderthals have communicated? Did they tell stories or myths as modern humans did and do?"

"…we make the following suggestions about Neandertal communication: 1. Neandertals had speech. Their expanded Broca's area in the brain and their possession of a human FOXP2 gene both suggest this. Neandertal speech was probably based on a large (perhaps huge) vocabulary: words for places, routes, techniques, individuals, and emotions…Neandertal language was direct and task-relevant. It was capable of referring to events in the past, or future, or at distant places, but only in ways connected to a context shared with the listener. There is no reason to think that Neandertals created elaborate stories or myths. Recall that Neandertals appear not to have used fire in the same social way that modern humans do. Moreover, they had few interactions with neighboring territorial communities, and therefore no reason to have modes of speech that could be used to interact with strangers or even acquaintances." (Wynn, Thomas & Coolidge, Frederick p. 131-132).

"…they [chimpanzees] don't vocalize (or use silent signs) to coordinate action. Humans clearly do, and we think that the Neandertals did as well. Effective hunting on the scale practiced by Neandertals would almost require some coordination via communication of information. For this reason (and others) we suspect that Neandertals had language." (Wynn, Thomas & Coolidge, Frederick p. 44).

SIDE NOTE on evolutionary advantage of language: "Anatomically modern human speech may not be solely a result of predation, but there is little question that vocal communication is a result of predation and is used as a protective tool by all primates, including hominids." (Hart, Donna & Sussman, Robert W. p. 186).

Ingestion

Teeth

"...analysis of enamel growth lines has shown that Neanderthal wisdom teeth erupted earlier than those of modern humans, coming in at age 15 instead of 18 or older." (Frayer, David).

Marks indicating nutritional stress in childhood:
"The presence of a significant number of linear enamel hypoplasias indicates that these individuals were stressed during childhood." (Hlusko, Leslea J. et. al. p. 477).

"Not only did Neandertals lead dangerous lives with high levels of physical exertion, but they also faced periodic food shortages…almost 40 percent of Neandertals suffered significant periods of poor nutrition as infants [as told from the hypoplasia - i.e. permanent pits & grooves in the enamel on the teeth]. And since they were almost certainly nursing at that point in their

lives, it also means that their mothers were under stress; hungers appears to have been common. But we must place this number in context before we can conclude that Neandertals were poor providers. When Guatelli-Steinberg applied the same techniques to prehistoric Inuit jaws from northern Canada that were a few hundred to a few thousand years old, she found the numbers to be the same: 38 percent presented evidence for hypoplasia. So the message here is not that Neandertals were inept hunters and gatherers, but that hunting and gathering in cold, hostile environments is always a risky, unpredictable affair." (Wynn, Thomas & Coolidge, Frederick p. 19).

"...in a sample of 669 carefully examined teeth from roughly 165 Neanderthals, hypoplastic enamel defects (pitting or grooving indicating periods of arrested enamel growth) appeared on 36%, representing 57% of the individuals...The implication is that young Neanderthals were much more commonly subjected to food shortage, trauma or disease." (Klein, Richard G. p. 584).

Shape, Size, 7 Molar Enamel

"Cheek teeth smaller than in earlier people and overlapping those of early, robust near-modern and modern people in size; incisors as large as or larger than those of earlier people and significantly larger than those of modern people...molar enamel thinner on average than in recent and other fossil humans." (Klein, Richard G. p. 447-448).

Anterior (Front Teeth)- Incisors & Canines

"The front teeth are the most distinctive part of the Neandertal dentition. The unworn incisors and canines of Neandertals are large, even by comparison with those of more primitive humans....the so-called 'classic' Neandertals of the later Würm, had smaller front teeth [and Neandertal front teeth continue to become smaller as time goes on]..." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1113-1114).

"It has also been suggested that the shovel-shaping of the incisors and the large size of the anterior teeth of Neandertals would have enabled them to bear and exert more powerful bite forces, and that the distinctive Neandertal morphology evolved for this purpose...Neandertal anterior teeth were involved in far more strenuous activities than routine biting and chewing." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. pp. 1115 & 1117).

Close-Up of Neanderthal Shovel Shaped Incisors

Source: AboveTopSecret. “The Neanderthal -- a comprehensive introduction to the fossil record.” <http://www.abovetopsecret.com/forum/thread930727/pg2>.

Posterior (Back) Teeth- Molars & Premolars
“Neandertals’ posterior teeth (molars and premolars) are less distinctive than their front teeth. They generally fall into the size range of modern human cheek teeth, which means they are reduced compared to earlier Homo.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. pp. 1119).

Tooth Wear & Microwear
“...cheek teeth usually less worn than incisors and canines (in contrast to most modern humans, whose anterior and posterior teeth tend to be about equally worn).” (Klein, Richard G. p. 447-448).

"Many Neandertals have heavily worn incisors, suggesting habitual, heavy use, perhaps as a kind of third hand." (Wynn, Thomas & Coolidge, Frederick p. 5).

“Neandertal incisors and canines are usually very heavily worn, even compared to the cheek teeth in the same individual...Wear on the incisors and canines often exceeded the capacity of the teeth to withstand it...[wear sometimes continuing onto the roots!]” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1114).

“Our results show that Neanderthals have not only significantly larger anterior roots than RMH [Recent Modern Humans] overall, but also different root shapes for each tooth type. In the context of the ‘teeth-as-tools’ hypothesis, this could be an adaptation to better sustain high or frequent loads on the front teeth.”(Le Cabec, Adeline et. al. p. 169).

“Here we describe dental remains from a Neanderthal fossil assemblage from Moula-Guercy, France....Molar microwear data suggest that these Neanderthals did not differ significantly from

modern humans in terms of the fracture properties of the food they were consuming. The incisor microwear and macro striations provide evidence that these individuals may have been using their anterior teeth as tools, similar to the practices of several modern human populations such as the Inuit, Ipiutak, and Australian Aboriginals, and reminiscent of evidence from other Neanderthals from Krapina, Croatia, as well as the 600,000 year old hominids from Sima de los Huesos, Spain." (Hlusko, Leslea J. et. al. p. 477).

"Microscopic examination of seven front teeth, incisors and canines, of individuals from Vindija Cave revealed a series of scratches. The most parsimonious explanation for these marks has to do with the table manners of Neanderthals. Observed among many groups around the world, meat eaters often hold a large portion in their teeth and use a knife to cut a bite-size piece off at their lips, the so-called stuff-and-cut method. Those knives, stone or steel, sometimes rubbed against the teeth and left scratches." (Price, T. Douglas).

"The most common explanation for the abnormal anterior tooth wear in some Neanderthal individuals involves the 'stuff and cut' scenario. According to this idea, Neanderthals used their front teeth as a clamp or third hand for grasping items that required processing with tools. This idea is closely associated with C. Loring Brace, who developed it based on ethnographic reports of Alaskan Eskimo and Canadian and Greenland Inuit groups that used their anterior dentition in this manner, to grasp chunks of meat as they sliced with a knife." (Krueger, Kristin L.; Ungar, Peter S. p. 651-652).

"Analyses of the Krapina teeth have also illuminated behavioral practices of the Neandertals. Grooves on the necks of some bicuspids and molars show that they used toothpicks to dislodge food stuck between these teeth. Studies of the wear patterns reveal that Neandertals wore down their front teeth more than their cheek teeth—indicating they used their incisors and canines as a third hand to grip and manipulate objects. Scratches left on the lip face of the same teeth provide further evidence for dental manipulations." (Frayer, David).

"We present a Neanderthal maxilla (CF-1) from Cova Foradà site (Oliva, Valencia, Spain) with periodontal disease and evidence of attempts to alleviate pain with the use of a toothpick....Heavy dental wear and periodontal disease would have caused the Cova Foradà Neanderthal specimen pain and discomfort, which the individual attempted to mitigate using some kind of dental probe." (Lozano, Marina et. al.).

Microwear Patterns have been analyzed to represent both more meat based as well as more varied diets, setting the stage for no clear cut conclusions to be made:

"Microwear patterns on Neandertal teeth strongly resemble those of the most carnivorous modern humans (e.g. Inuit, Fuegans) as opposed to people with more generalized diets." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1176).

“Subvertical grooves on the interproximal surfaces of teeth offer another line of dietary evidence for Neanderthals. These large furrows on the interproximal wear facets, usually of molars, have been observed on a number of Neanderthal specimens, including Figueira Brava (Portugal, Antunes and Santhino Cunha, 1992), Caverna delle Fate (Italy, Giacobini et al., 1984), Fondo Cattie (Italy, Borgognini Tarli, 1982), Genay (France, de Lumley, 1987), and Cueva de Sidro´ n (Spain, Egocheaga et al., 2004). While some have attributed these grooves to post-depositional processes (Antunes and Santhino Cunha, 1992), others have suggested that they are related to high masticatory stress associated with consuming hard food materials (Wolpoff, 1971; Osborn and Ten Cate, 1983). A comparison of subvertical grooves from Cueva de Sidro´n and Figueira Brava with some H. heidelbergensis remains from Simi de los Huesos (Spain) led Egocheaga et al. to suggest that ‘‘the most probable cause of the subvertical grooves being natural biomechanical processes combined with some dietary habits indicative of hard plant foods ingestion’’ (2004, 49). The dental evidence of diet, then, stresses variability in diet, indicating not only carnivory, but the possible inclusion of hard plant foods, possibly USOs, in the diet of some Neanderthals.” (Hardy, Bruce L. p. 664).

C3 & C4

Carbon Isotope Analysis of Neanderthal Teeth

“There are two main photosynthetic pathways, C3 and C4, the latter found only in plants living under warm and seasonally dry conditions. In the northern hemisphere at middle latitudes, such as Western Europe, all plants use the C3 photosynthetic pathway (Farquhar et al., 1989). Previous studies have shown that C3 plants typically have more negative carbon values in closed, forested habitats, while C3 plants in open and drier habitats have more positive isotopic values (Farquhar et al., 1989; van der Merwe and Medina, 1991; O’Leary et al., 1992; Heaton, 1999; Drucker et al., 2008).” (Ecker, M. et. al. p. 2-3).

“The main carbon isotopic distinction in terrestrial vegetation is due to the photosynthetic pathway used by plants, i.e. the so called C3 and C4 pathways. C4 plants are absent or very limited in environments with a temperate or cold growing season, as in Europe, including the Mediterranean area, northern latitudes and high altitudes. The geographical extension of Neanderthals was deeply rooted in Europe, with representatives in the Middle East and central Asia (e.g., Bolus and Schmitz 2006; Finlayson and Carrion 2007). Within this range, C4 plants may be present as a significant but minor component in the Middle East and some dry sections of Central Asia (e.g. Bocherens et. al. 2000). When present, these C4 plants are grasses or forbs. In environments where all plants use the C3 photosynthetic pathway, which correspond to the large majority of sites where Neanderthals occurred, an isotopic distinction can be seen between plants growing under a closed canopy, which have lower carbon 13 isotope values than plants growing at the top of the canopy or in open environments, such as open woodland, grassland, steppe and tundra (reviews in Tieszen 1991; Heaton 1999).” (Bocherens, Herve p. 76).

“Brown bear is the carnivore with carbon and oxygen isotopic values closest to that of the Neanderthal, which may suggest a similar omnivorous diet for both brown bears and the hominins at Payre.” (Ecker, M. et. al. p. 8).

“The distribution of the oxygen and carbon isotope values suggests that red deer were preyed on by hominins on the plateau while horses were preyed upon in the Rhone Valley...This study is the first to investigate Neanderthal diet by studying carbon and oxygen isotopes in hominin tooth enamel.” (Ecker, M. et. al. p. 9).

NOTE: “Isotopic investigations of fossil bones relevant to questions of Neanderthal paleoecology are only at their beginning [as of 2011]. So far, only about 25 Neanderthal individuals have been attempted using this new isotopic approach, and only 12 specimens yielded well-preserved collagen, ten of them having been published (Bocherens et. al. 2005b)....There are still a huge number of prehistoric sites dated to the Late Pleistocene that should yield fossil bones and teeth suitable for collagen and/or enamel apatite isotopic studies...in the coming years.”(Bocherens, Herve pp. 81-82).

Tool Use

"For all of their dogged courage and resilience, they didn't make much technological progress during their two-hundred-thousand-year run in Europe. The Mousterian tools and cultural artifacts they crafted and left behind show remarkably little innovation considering how long they were around. The craftsmanship is first-rate, and the design of the tools and the methods used to fashion them were clearly passed along quite precisely, but given their intelligence, you would have expected more novelty, more originality." (Walter, Chip p. 112).

“The Neanderthals made complex and sophisticated stone tools that they fashioned into a wide variety of tool types such as scrapers and points....But the Neanderthals, in spite of their accomplishments, were not entirely modern in their behavior. They made few tools out of bone, including needles...” (Lieberman, Daniel).

“Although bone is plentiful in some Neandertal sites and used pieces of bone are not rare, skillfully shaped bone tools are generally lacking in Mousterian contexts.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1172).

“Sophisticated bone technology is directly associated with Neandertals in Initial Upper Paleolithic levels...and bone points are widespread in Initial Upper Paleolithic entities...All of these occurrences fall toward the end of the Neandertal time span.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1172).

“The cultural complex generally associated with Neandertals is known as the Mousterian, named for the French site of La Moustier. The Mousterian is a flake-based industry in which various techniques were used to pre-shape the flake before it was struck from the

core...Mousterian assemblages are characterized by high frequencies of various types of side-scrapers, but also encompass denticulates, notches, flake-blades, and points." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1169-1170).

"Handaxes, racloirs (Side-Scrapers) and points constitute the [Mousterian] industry; sometimes a Levallois technique or another prepared-core technique was employed in making the flint flakes." (Wikipedia Online Encyclopedia "Mousterian" Accessed 6/19/2014 <http://en.wikipedia.org/wiki/Mousterian>.).

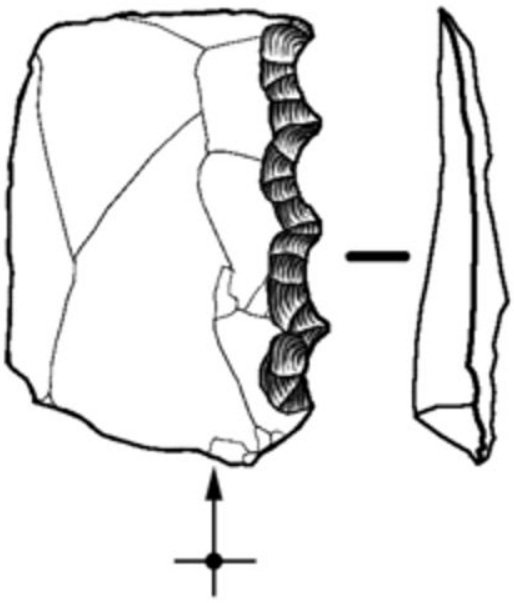
Hand Axes

The first published picture of a hand axe, drawn by John Frere in the year 1800. (Public Domain).

Side-Scraper

(Source: José-Manuel Benito Álvarez (España) - Racloir from Galería (TG11); in Public Domain).

Denticulate (similar to a saw with one or two ridged sides)



(Source: José-Manuel Benito Álvarez (author); Under the license: http://creativecommons.org/licenses/by-sa/2.5/).

“...a denticulate tool (pictured above) is a stone tool that displays one or more edges that are worked into multiple notched shapes, much like the toothed edge of a saw. Indeed, these tools might have been used as saws, more likely for meat processing than for wood. It is possible, however, that some or all of these notches were used for smoothing wooden shafts or for similar purposes. These tools are included in the Mousterian tool industry by Neanderthal culture, proceeded by small hand axes and side scrapers.” (WIKI: “Denticulate Tool” Retrieved 1/6/2014 from <http://en.wikipedia.org/wiki/Denticulate_tool>.).

“Use-wear analysis of Mousterian tools shows that most of them were used for working various materials, including wood, bone, hides, and meat...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1170).

“Wood must have been far more widely used in Mousterian technology than these few preserved artifacts would indicate.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1171).

"…Neandertals' ancestors had hunted large animals using spears. It was clearly an established form of hunting, and technology, as Neandertals evolved. At some point later in time, perhaps as early as 200,000 years ago, Neandertals escalated the prehistoric arms race by attaching a sharp stone point to the ends of their spears. In Neandertal times the simplest (not the easiest!) spear point was a flat, triangular-shaped stone tool that was sharp along two edges, something archaeologists call a 'Levallois point'. They were effective, but they were very difficult to make." (Wynn, Thomas & Coolidge, Frederick p. 50-51).

Levallois Point

(Source: Didier Descouens (author); Image of: Levallois point from Beuzeville, France; Under the license: http://creativecommons.org/licenses/by-sa/3.0/)

"The first engineering design in the history of technology may have been the hafting of a stone point onto a wooden shaft…So how did the Neandertals do it? Archaeologists have direct evidence of one of the solutions. From a site in Syria they have excavated a point whose base was covered with bitumen, a kind of natural asphalt. These Neandertals glued the point on. This is not as simple as it sounds. First, they had to acquire the bitumen, then they probably had to heat it to make it workable, after which they had to position the point on the shaft in such a way that the bitumen only channeled the force to the shaft; it would not have been strong enough to bear the direct force itself. In western Europe Neandertals used pitch made from birch bark. Other Neandertals may have tried tying the point onto the shaft, but there are no direct remains of such lashing." (Wynn, Thomas & Coolidge, Frederick p. 55).

"Neandertals almost never innovated. Indeed there is only one clear example of Neandertal invention, hafting, though we suspect there must have been others yet to be identified…They did a lot of tweaking, making slight changes to established techniques, but active invention was just not a common component of their technology. For tens of thousands of years they were content with their basic technological profile." (Wynn, Thomas & Coolidge, Frederick p. 72).

"…Neandertals almost never came up with new ways of doing things. As important as it is to understand how Neandertals might have innovated, it is important also to remember that they almost never did. And this virtual absence is perhaps the single most important difference between Neandertal technical thinking and ours." (Wynn, Thomas & Coolidge, Frederick p. 69).

"They varied their knapping techniques according to the nature and availability of raw material and regularly squeezed maximum use out of their tools by modifying them into several successive tool types." (Wynn, Thomas & Coolidge, Frederick p. 71).

Use of Fire

"Neandertals did use fire, often and effectively, but the range of uses differed slightly from ours…By the time of Neandertals, fire use and cooking had long been established components of hominin life. Neandertals could not have survived in the cold of glacial Europe, nor consumed the massive quantity of meat that was their primary diet, without fire. They clearly knew how to keep and maintain it. We suspect that they also knew how to make it through friction, or perhaps even by creating sparks using meteoric iron to strike flint."(Wynn, Thomas & Coolidge, Frederick p. 114).

"We conclude that Middle Paleolithic Neandertals…had the ability to make, conserve, and transport fires during successive occupations or at different sites…" (Roebroeks, Wil & Villa, Paola p. 5211).

“Neandertals made extensive use of fire, and many Mousterian sites have evidence of well-defined hearths. These may be no more than thin deposits of charcoal, burned bones, and ash, but many sites have evidence of hearths recurring at the same place over long periods of time...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1172).

The First Evidence of the habitual & controlled use of fire in Europe:
“All evidence of control of fire during the Lower Paleolithic is uncertain and has at best limited scholarly support. In fact, definitive evidence of controlled use of fire is one of the factors characteristic of the transition from the Lower to the Middle Paleolithic in the period of 400,000 to 200,000 BP.” (Wikipedia, the Free Online Encyclopedia “Control of Fire by early Humans.” Accessed 6/19/2014).

"Our review of the European evidence suggests that early hominins moved into northern latitudes without the habitual use of fire. It was only much later, from ~300,000 to 400,000 years ago onward, that fire became a significant part of the hominin technological repertoire…The increase in the number of sites with good evidence of fire throughout the Late Pleistocene shows that European Neandertals had fire management not unlike that documented for Upper Paleolithic groups." (Roebroeks, Wil & Villa, Paola p. 5209).

"…evidence for use of fire in the Early and early Middle Pleistocene of Europe is extremely weak. Or, more exactly, it is nonexistent, until ~300-400 ka. Our review of the early European sites shows that the earliest possible evidence of fire comes from two sites dated to ~400ka, Beeches Pit in England and Schöningen in Germany. At Schöningen, the evidence consists of some heated flints (although mostly natural pieces) and charred wood, including a wooden tool, with the studies of possible remains of former hearths still in progress. At Beeches Pit…the evidence consists of heated lithics and heated sediments, interpreted as the remains of hearths." (Roebroeks, Wil & Villa, Paola p. 5210).

"We suggest that the European record displays a strong signal, in the sense that, from ~400,000 to 300,000 years ago, many proxies indicate a habitual use of fire, but from the preceding 700,000 years of hominin presence in Europe, we have no evidence for fire use." (Roebroeks, Wil & Villa, Paola p. 5210).

"In sum, the European evidence strongly suggests that the habitual and controlled use of fire was a late phenomenon, dating to the second half of the Middle Pleistocene, which is not deny the possibility of occasional and opportunistic use of fire in earlier periods." (Roebroeks, Wil & Villa, Paola p. 5212).

"Apparently, in addition to wood, bone was used as fuel as well." (Roebroeks, Wil & Villa, Paola p. 5210).

"Stone-lined or stone-delimited fireplaces are not as common as in the late Upper Paleolithic, but they have been documented at a number of Middle Paleolithic sites…" (Roebroeks, Wil & Villa, Paola p. 5210).

Neanderthals' Uses of Fire
"They may even have used fire to alter the flaking characteristic of stone." (Wynn, Thomas & Coolidge, Frederick p. 116).

Side Note on Hunting, Meat Eating & Fire: "Lastly, let us mention the obvious - no hominids hunted on a large scale before the advent of controlled fire. Again, we just don't have the dentition or the digestive tract of a carnivore; our anatomy and physiology did not particularly suit us for digesting meat until the mastery of cooking solved the problem. Our intestinal tract is short and pre-digestion by fire had to precede any major meat-eating." (Hart, Donna & Sussman, Robert W. p. 230).

"Neanderthals used fire to synthesize from birch bark a pitch for hafting stone tools." (Roebroeks, Wil & Villa, Paola p. 5210).

"Neandertal Synthetics. Recent data shows that European Neandertals from at least 200,000 years ago onward used fire to synthesize from bark a pitch for hafting stone tools…How this was actually achieved by Neandertals and prehistoric modern humans is not known, although birch bark pitches have been experimentally produced in small dug out and subsequently covered pits beneath camp fires…These are artificially produced materials, synthesized by Neandertals using fire as a tool. Neanderthals also used fire to heat-treat existing natural materials, such as asphalt, for hafting purposes; this is clear from 42,000- and 70,000- year old tools with traces of bitumen on their surfaces from the site Umm El Tlel (Syria), on the southern edge of the Neanderthal world. That asphalt was collected at 40 km from the site." (Roebroeks, Wil & Villa, Paola SI Text p. 1-2).

"It is also from the second half of the Middle Pleistocene onward that we can observe some spectacular cases of pyro-technological knowledge in the production of hafting materials, which some consider a proxy for complex, modern cognition." (Roebroeks, Wil & Villa, Paola p. 5210).

The Other Ways Fire was and is used marks a Distinction between Neanderthals vs. Modern Humans

"This is why people invested effort to build fireplaces that would allow long-burning fires. Homo sapiens sapiens used them for more than cooking; they used them to help create a spiritual life. Neandertals never appear to have done this. It is one of the most profound differences between them and us." (Wynn, Thomas & Coolidge, Frederick p. 118).

"Hearths had become a focus of social life. Long after cooking was done, people sat around the fires and talked, recited myths, and performed rituals. This is a familiar use of fire in the twenty-first century, and has been for at least 25,000 years. It is this kind of fire use that has never been found with Neandertals. It marks an important social difference between Neandertals and us…" (Wynn, Thomas & Coolidge, Frederick p. 117).

"The lack of intense fire suggests that Neandertals did not have any kind of narrative tradition or symbolic ritual life…Neandertal life was not immersed in symbols." (Wynn, Thomas & Coolidge, Frederick p. 124).

Shelters

“The archaeological record shows that Neandertals used both fire and artificial shelters. Aiello and Wheeler (2003) suggest further that Neandertals would have needed artificial body covering (clothing of some sort) with an insulation value at least equal to a modern business suit in order for them to survive away from fires and shelters in subfreezing temperatures.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1131).

“Contrary to general opinion, the Neanderthals were not pure cave dwellers, but also built a kind of tent at the entrance of their caves for protection and on the steppes probably constructed very simple shelters from mammoth tusks and bones. The remains of such shelters can be found on the western edge of Central Asia near Molodova in the Ukraine, among other places.” (Baumer, Christoph).

“Neanderthals used caves and rock shelters where they existed, but, in all probability, constructed shelters in open environments.” (Reeve, Eric C.R.).

“As for shelter, caves would have afforded protection from the elements. But some Neandertals appear to have built their own dwellings: At a site known as the Grotte du Renne in Arcy-sur-Cure, France, archaeologists found remnants of post holes - a sign that residents had built a structure from mammoth tusks that they probably draped with tanned hides to form a cozy tent of sorts.” (Johanson, Dr. Donald; Wong, Kate).

Clothing

“Although Mousterian tools were probably used to work hides, which suggests that Neandertals were capable of producing some form of clothing, there is no evidence of the bone needles and other artifacts that signal the presence of more efficient, tailored clothing in the Upper Paleolithic.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1173).

"Regarding the smoking of hides, although it is certainly possible that Neandertals made use of animal hides to some degree, there is little evidence to indicate extensive, or at least well developed, hide processing in the Western European Mousterian…Thus, if Neandertals did use hide as a raw material for clothing, containers, and/or shelter, their hide-processing technology was likely rudimentary and not developed to the point where smoking would have been employed." (DM Sandgathe, HL Dibble, P Goldberg, SP McPherron, A Turq, L Niven, J Hodgkins p. 218).

“Scientists have also recovered scrapers and awls (larger stone or bone versions of the sewing needle that modern humans use today) associated with animal bones at Neanderthal sites. A Neanderthal would probably have used a scraper to first clean the animal hide, and then used an awl to poke holes in it, and finally use strips of animal tissue to lace together a loose-fitting garment. Neanderthals were the first early humans to wear clothing, but it is only with modern humans that scientists find evidence of the manufacture and use of bone sewing needles to sew together tighter fitting clothing.” (Smithsonian National Museum of Natural History. “Homo Neanderthalensis - How They Survived.”).

"The needle is part of the Upper Paleolithic toolkit – part of the “cultural revolution” that dates from around 50,000 years ago. Evidence on the evolution of the human body louse, an insect that lives in human clothing, also supports the view that clothing was invented around 50,000 years ago. The tools associated with Neanderthals, which underwent little change during the many thousands of years in which they ruled Europe and Asia are, in contrast, Middle Paleolithic. The evidence strongly suggests that Neanderthals did not invent or use the needle and that they could not sew. Even if they had adopted the use of needles at the time they were first introduced, that would not explain how they managed to survive in the Northern Hemisphere during the previous 70 or 80 millennia without a coat of fur. All the other mammals that made it through the Ice Age – the mammoth, for instance – were furry." (Harris, Judith R.).

"Substantial shoes protect the feet, producing a decline in the robustness of foot bones after hominins start wearing shoes regularly. Comparisons indicate that both modern humans and Neanderthals went barefoot or wore light footwear only irregularly before approximately 28,000 years before present. Barefoot hominins would have had great difficulties in boreal regions with permafrost." (Shipman, Pat p. 14241).

Some believe Neanderthals might have made their way to the Greek Islands by boat:

“Archaeological data from the southern Ionian Islands show human habitation since Middle Palaeolithic going back to 110 ka BP yet bathymetry, sea-level changes and the Late Quaternary geology, show that Kefallinia and Zakynthos were insular at that time. Hence, human presence in these islands indicates inter island-mainland seafaring. Seafaring most likely started some time between 110 and 35 ka BP and the seafarers were the Neanderthals.” (Ferentinos, George et. al. p. 2167).

“Recently, the discovery of stone-tools in Crete, found in a flight of uplifted terraces and alluvial fans dated between 130 and 45 ka BP and, the likely insulation of Crete from the surrounding land masses since the Miocene, suggests that sea-going in the Mediterranean was started much earlier by pre-Sapiens hominins (Strasse et al., 2011).” (Ferentinos, George et. al. p. 2167).

“Mousterian stone tools discovered on the southern Ionian Greek islands suggests that Neanderthals were sailing the Mediterranean Sea as early as 110,000 years BP. Quartz hand-axes, three-sided picks, and stone cleavers from Crete have also been recovered that date back about 170,000 years BP.” (Wikipedia, the Free Online Encyclopedia “Neanderthal Behavior”).

“The first voyagers who travelled to the Ionian Islands were the Neanderthal hunter-gatherers, who occupied the Greek mainland at that time...” (Ferentinos, George et. al. p. 2175).

Society

Community Size & Composition

"Neandertals spent their daily lives in very small face-to-face groups, which are groups of individuals in more or less direct contact, if not physically, then within eyesight or hearing."(Wynn, Thomas & Coolidge, Frederick p. 75).

"…their clans could not have been large…small groups, hardly more than extended families really, twelve, maybe as many as twenty-five people…" (Walter, Chip p. 107).

"Based on what we know of the archaeological record and the comparative evidence of nonhuman primates and human hunter-gatherers, we find the following sketch of Neandertal social groups to be most likely. Neandertals lived in communities of fewer than a hundred individuals, perhaps ten to twenty families related through the male line or female line (male or female philopatric). Based on movement of raw material, Neandertal communities in western Europe occupied a territory of perhaps 2,000 square kilometers; larger territories characterized Neandertals in eastern Europe, perhaps because of a different distribution of game. The families consisted of a pair-bonded man and woman, their children, and perhaps a surviving older relative. These families were the primary foraging unit, with all members participating in

the hunt….The several families of a community came together when big kills were made…and stayed together as long as the meat lasted. Members of the community had fairly regular contact with one another, but little contact with neighboring communities." (Wynn, Thomas & Coolidge, Frederick p. 91).

Rare Interaction with Neighboring Communities
"The archaeological evidence suggests that Neandertal communities were relatively small and thinly spread across the landscape. There is no evidence for regular interaction with neighboring communities, though there is evidence of occasional contact - the rare bits of high-quality raw material." (Wynn, Thomas & Coolidge, Frederick p. 90).

Note: "The modern humans who entered central and western Europe beginning 40,000 years ago lived in larger face-to-face groups than Neandertals did, maintained regular social contacts with acquaintances who lived hundreds of kilometers away…" (Wynn, Thomas & Coolidge, Frederick p. 98).

The Overall Estimated Population Size of Neanderthals
"…their worldwide population never reached into six figures…" (Walter, Chip p. 104).

"…nor, so far as we can tell, did they often live more than thirty years or so…genetic information gleaned from a handful of bones indicates that the total population of adult Neanderthals at most reached seventy thousand, and during the last forty thousand years of their existence probably dwindled to ten thousand." (Walter, Chip p. 107).

“The bottom line is that the Mousterians appear to have been less numerous than their successors, probably because they exploited the available animal and plant resources less efficiently....Neanderthals almost certainly needed more calories per individual than their successors and a set number of calories would have supported fewer individuals. Thus even if Neanderthals extracted as much energy from nature as their successors, their populations would have been smaller.” (Klein, Richard G. p. 577).

Neanderthal Society lacked older adults & their insight
"Only about one-third of adult Neandertals were older when they died, but two-thirds of modern humans were from the older group (based on a skeletal sample of modern humans who lived 20,000 years ago). Given the dangers of Neandertal life this difference is perhaps not surprising, but it does have implications for Neandertal social life. First, many adults died young, at an age when they had young children. Second, there were only a few older adults available, and most of these were probably in a physical condition similar to La Chapelle or Shanidar #1-broken down and marginally productive. In other words, adult knowledge, experience, and labor were in short supply, compared at least to the modern humans who followed them. In this, Neandertals were no different from other human populations living at the

same time, including our ancestors. Life in the Palaeolithic was tough all over." (Wynn, Thomas & Coolidge, Frederick p. 81).

"Neanderthals became so focused on their short-term need to survive that they were unable to develop the more complex skills that saved us Homo sapiens over the long haul." (Walter, Chip p. 127).

Division of Labor by Age & Sex

"Neandertals almost certainly had pair-bonds…Neandertals were about as sexually dimorphic as modern humans, and it is reasonable to conclude that pair-bonding with provisioning was an essential component of their social lives." (Wynn, Thomas & Coolidge, Frederick p. 83).

"Neandertals probably lacked a significant division of labor based on sex and age…Either Neandertal women and children did nothing to aid the food quest, which is unlikely, or they were part of the regular hunting strategy. This also makes sense of features of Neandertal anatomy. Neandertals show evidence of heavy exertion even at a young age. If all Neandertals participated in hunting, we would expect this. Neandertal adult males often suffered upper body injuries, but adult females not as much. This suggests that women and children performed different, and less dangerous, tasks during a hunt. [The archaeologists Mary Stiner and Steven Kuhn] suggest that the women and children could have helped drive the animals or beat the bushes to expose the location of game. But even if women and children just helped butcher and transport meat back home, their bodies would tell a tale of heavy exertion." (Wynn, Thomas & Coolidge, Frederick p. 33).

"Neandertal women show far fewer severe bodily injuries than the men, which suggests that they did not participate in the in-close killing of animals. But there are many other roles that they could have played, including driving animals or distracting them. And the women almost certainly participated in butchering and transport. Nevertheless, compared to modern hunter-gatherers, Neandertals had low levels of division of labor." (Wynn, Thomas & Coolidge, Frederick p. 86).

“As hunter-gatherers, Neandertals were expected to share the same kind of social organization and survival strategies as modern hunter-gatherers, which implies a partitioning or division of labor between sexes inside the group. However, the lack of grinding stone artifacts and the scarcity of evidence for specific activities linked to modern hunter-gatherer women indicate that Neandertals might not have had such extreme sex-related specialization, at least in terms of the provisioning of food, with both males and females participating in the hunting of big game.” (Estalrrich, Almudena; Rosas, Antonio).

“The characteristics and distribution of this type of dental wear within a group or population has the potential to provide information about production activities and the division of labor within those groups or populations (Berbesque et al., 2012)....Neandertals are known to have extensively utilized their dentition in non-masticatory activities, such as food preparation, tool

production, and preparation of skins...In the Neandertal samples analyzed here, the fundamental observation is that all of the individuals present instrumental striations and dental chipping, regardless of provenance, age, and sex. Thus, similar behaviors could be expected among them, with all members of the groups performing tasks involving their teeth as tools, and leaving similar type of marks....In light of the results discussed above, it seems that all Neandertals in our sample used their anterior dentition for non-masticatory activities, regardless of their age and sex. However, subtle differences have been found among them. The females have more striations than males, and the striations are longer....Some of the activities that may be underlying these differences could be the preparation of skins, spinning, and manufacture of leather products or clothing, which are more frequently performed by females in modern hunter-gatherer societies (according to Murdock and Provost, 1973)....In addition to what emerges from the study of instrumental striations, dental chipping also shows a consistent sexual pattern in the analyzed sample. In this group, females display a higher incidence of this trait on their mandibular teeth, while males show a higher prevalence on their maxillary teeth." (Estalrrich, Almudena; Rosas, Antonio).

Summary of article quoted above:

"Neanderthal communities divided some of their tasks according to their sex. This is one of the main conclusions reached by a study performed by the Spanish National Research Council (CSIC), published in the Journal of Human Evolution. This study, which analyzed 99 incisors and canine teeth of 19 individuals from three different sites (El Sidron, in Asturias -- Spain, L'Hortus in France, and Spy in Belgium), reveals that the dental grooves present in the female fossils follow the same pattern, which is different to that found in male individuals. Analyses show that all Neanderthal individuals, regardless of age, had dental grooves.According to Antonio Rosas, CSIC researcher at the Spanish National Museum of Natural Sciences: "This is due to the custom of these societies to use the mouth as a third hand, as in some current populations, for tasks such as preparing the furs or chopping meat, for instance."
Rosas specifies that "what we have now discovered is that the grooves detected in the teeth of adult women are longer than those found in adult men. Therefore we assume that the tasks performed were different."

Other variables analyzed are the tiny spalls of the teeth enamel. Male individuals show a greater number of nicks in the enamel and dentin of the upper parts, while in female individuals these imperfections appear in the lower parts.

It is still unclear which activities corresponded to women and which ones to men. However, the authors of the study note that, as in modern hunter-gatherer societies, women may have been responsible for the preparation of furs and the elaboration of garments. Researchers state that the retouching of the edges of stone tools seems to have been a male task.
Almudena Estalrrich, CSIC researcher at the Spanish National Museum of Natural Sciences, adds: "Nevertheless, we believe that the specialization of labor by sex of the individuals was

probably limited to a few tasks, as it is possible that both men and women participated equally in the hunting of big animals."" (Spanish National Research Council - CSIC).

Art, Ornamentation, & Use of Pigments

"...like earlier peoples and unlike later ones, Mousterian/MSA [i.e. Neanderthal] peoples left remarkably little evidence for art or ornamentation." (Klein, Richard G. p. 529).

"The most convincing art objects associated with Neandertals are probably the items of personal adornment (grooved and bored teeth and other ornamental pieces) from the Châtelperronian levels at Grotte du Renne at Aray-sur-Cure." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1194).

"The supposedly artistic or symbolic objects that have been claimed from strictly Mousterian [Neandertal] contexts are few in number and unimpressive in appearance. Bones or teeth that appear to have been pierced or scored for hanging (perhaps around the neck, as primitive jewelry) are known from such sites as LaQuina in France, Scalyn in Belgium, and Prolom II in Ukraine. Bones and pieces of stone from several Mousterian sites bear marks that may have been intentionally made by humans for no evident functional purpose, and a piece of mammoth molar shaped into an oval plate has been recovered from Tata in Hungary." (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1193).

"Neandertals produced no depictions. There is nothing in the extensive archaeological record that could in any way be construed as a Neandertal representation of an animal, or a person, or indeed of anything." (Wynn, Thomas & Coolidge, Frederick p. 119).

[However]…"The Neandertal archaeological record does offer several provocative items. In some sites archaeologists have recovered rock crystals that Neandertals apparently picked up and carried home. At the Hungarian site of Tata archaeologists found a round river cobble that had a straight crack running from one edge to the other. A Neandertal had engraved a second line perpendicular to the crack. From two sites in Spain, Cueva de los Aviones and Cueva Anton, there are perforated marine shells most likely used as pendants. Such artificial examples suggest an attraction to patterns and perhaps a concern for appearance, but there are so few of them that it is dangerous to generalize. (Indeed until the Cueva de los Aviones pendants were found, there were no unambiguous examples of Neandertal ornaments in the entire archaeological record.) Use of mineral pigments was far more common. These are minerals such as hematite and manganese dioxide that produce a distinct colored mark when scraped across a surface or which can be ground into colored powder. The most common is known as ochre (hematite), which comes in colors from red through yellow and orange. It is common in prehistoric sites around the world, and its earliest use extends back as far as 300,000 years ago in Africa, to the time of Homo heidelbergensis. Neandertals also used ochre, but manganese dioxide was even more common; pieces of manganese have been found

in more than forty European Neandertal sites. Most of the pieces have evidence of scraping to produce a black powder, and some were ground into pointed shapes, perhaps to use as a kind of pencil…Perhaps Neandertals used manganese powder similarly as a binding agent for their glues, but there is no evidence for such use. The more provocative explanation is that Neandertals used the manganese powder to color something, perhaps their bodies, an interpretation given more power by the rare examples of pendants." (Wynn, Thomas & Coolidge, Frederick p. 120).

Religion/Traditional Practices

Burial of the Deceased, the Possibility of Neanderthal Religion, & Potential Remains of a Cannabalistic Feast -

“Evidence of ritual or religion among Neandertals is as sparse as evidence of Neandertal art.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1195).

“Neandertals were the first humans who buried their dead (at least sometimes).” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1016).

“It is often claimed that Neandertals were the first humans to bury their dead, but the issue is not a simple one. Not all Neandertal sites with human remains preserve any evidence of burial.”(Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1195).

“...they [Neanderthals] buried their dead, at least on occasion...there are no instances where Neanderthal skeletons are accompanied by special artifacts or other indisputable grave goods. However, burial pits have been reported in France from La Chapelle-aux-Saints, La Ferrassie, and Le Roc de Marsal and in Israel at Kebara Cave.” (Klein, Richard G. p. 571).

“Specialists employing different criteria estimate different numbers of Neanderthal burials, but there is consensus on about thirty-five, split more or less evenly between Europe and western Asia.” (Klein, Richard G. p. 572).

“The case of deliberate interment of Neandertal dead comes mainly from three other sorts of evidence: the recognition of burial pits at some sites, the flexed position in which several Neandertal bodies appear to have been laid to rest, and the state or preservation and completeness of many Neandertal skeletons.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1196).

"One of the few commonly known facts about Neandertals is that they buried their dead…There are few, perhaps no, real graves in the sense that we think of them. Most often Neandertals simply took advantage of a natural depression, such as the one at the rear of La Ferrassie, or perhaps expanded a natural low spot by scraping out some earth. They then positioned the

corpse, bending the limbs a bit if necessary, and perhaps covered it with some earth or debris. That's all." (Wynn, Thomas & Coolidge, Frederick p. 105-108).

“Neandertal bones from several sites...bear cutmarks and other evidence of postmortem processing...” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1195).

“But it is not clear whether this treatment of the dead among Neandertals should count as symbolic behavior or subsistence activity. T. White (1992, 2001) views these processed remains as the leftovers from cannibal feasts driven by hunger. It has even been suggested that the Neandertals were pushed into extinction by prion diseases (which include kuru and mad cow disease) that they contracted by feeding on the brains of their own dead (Chiarelli 2004). On the other hand, M. Russell argued that the processing evident on the Krapina folk shows evidence of secondary burial - that is, the ceremonious reburial of human skeletons, which often involves bone-cleaning that can leave cutmarks.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1196).

“At Moula-Guercy, a cave site along the Rhone River in southern France, Neandertals practiced a very different form of corpse treatment: cannibalism. The site was occupied about 100,000 years ago during a relatively warm climatic phase. In size and layout it resembles most other Neandertal cave sites, a place where a small group resided off and on, making and tending fires and butchering and cooking animals they had killed. But among the butchered carcasses of red deer and goat were the butchered carcasses of six Neandertals. The bones have the same kinds of butchery marks as other animals, including cut marks where a shoulder had been cut from the torso, others where the Achilles tendon had been sliced through, and the temporalis muscles stripped from the skull. The thigh bones had been smashed to get at the marrow, and the skulls shattered to access the brains. It was an efficient job of butchery, with cooking and eating the ultimate goal. Of the six Neandertals, two were adults, two were teenagers, and two were children between 6 and 7 years old, possibly the remains of all or most of a single Neandertal residential group. It is unlikely that such a group died natural deaths, and by extension unlikely that this was a form of ritual corpse disposal."(Wynn, Thomas & Coolidge, Frederick p. 108).

“...despite the evidence of Moula-Guercy XV, Neanderthals probably rarely ate each other.” (Klein, Richard G. p. 575).

<u>Neanderthals and Cannibalism</u>

There is no real evidence for this supposition: "Our Neanderthal cousins, in particular, have been tarnished with the stain of cannibalism almost since their fossil remains were first discovered. 'As for Neanderthals, scholars in the early part of the [twentieth] century assumed most routinely that they practiced cannibalism, an idea that fitted the prevailing view of Neanderthals as shambling, uncultured brutes'…Erik Trinkaus, Professor of Anthropology at Washington University in St. Louis and world authority on Neanderthals, estimated there is only

one confirmed instance of violence in the Neanderthal fossil record." (Hart, Donna & Sussman, Robert W. p. 266).

“In short...Processing of Neandertal bones may have been part of a reburial ritual, but it might also reflect hunger-driven cannibalism, or something else altogether.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1198).

“Evidence indicating cannibalism would not distinguish Neanderthals from modern Homo sapiens. Ancient and existing Homo sapiens are known to have practiced cannibalism and/or mortuary defleshing (e.g., the sky burial of Tibet). Grooves in bones are hypothesized to be cuts by Neanderthal tools, not animal teeth. The chances of them being random, as some writers attributing them to animals have proposed, is debated.” (Wikipedia, the Free Online Encyclopedia. “Neanderthal Behavior” Accessed 6/23/2014).

However, the tightly flexed positions could imply a burial ritual or rather simply a desire to dig the smallest hole: “Neanderthal graves present the best case for Neanderthal spirituality or religion, but more prosaically, they may have been dug simply to remove corpses from habitation areas. In sixteen of the twenty well-documented Mousterian graves in Europe and western Asia, the bodies were tightly flexed (in near fetal position), which could imply a burial ritual or simply a desire to dig the smallest possible burial trench.” (Klein, Richard G. p. 572).

“The evidence for ceremonial burial would be more convincing if there were evidence that the Neandertals regularly buried artifacts or food with the dead. But as Harrold (1980) showed some years ago, Neandertal burials are simple affairs and rarely contain any evidence of grave goods.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1198).

"Neandertal corpse treatments were minimal, and more telling, ad hoc. As far as we can reconstruct from the evidence, Neandertals had no recurrent techniques for treating corpses. Most often they simply hid them by whatever means was easily available…There were no grave goods and no standard orientation. We suppose it is possible that Neandertals practiced elaborate rites that we just do not see in the paleoanthropological record. We just find it unlikely." (Wynn, Thomas & Coolidge, Frederick p. 110-111).

"Neandertal corpse treatment was minimal, they did not use fire for expanded social interaction, and they did not have elaborate decorative traditions." (Wynn, Thomas & Coolidge, Frederick p. 121).

“In sum, there is little evidence or no evidence that the Neanderthals or their near-modern contemporaries practiced ritual or ceremony when they buried their dead. Both kinds of people clearly dug graves, at least sometimes, but the motivation need not have been religious, and the graves tended to be much simpler than those of their fully modern successors.” (Klein, Richard G. p. 573).

"Perhaps Neandertals did believe that something of an individual continued after death. But if they did, it must have been a short-term continuance. Evidence from sites such as Krapina and Kebara suggest that Neandertals returned to these mortuary caves, and often lived among the disturbed bones of previously hidden corpses, whose remains were shoved aside in the same way all bones were shoved aside. If any element of the deceased was thought to have continued after death, it apparently was not thought to continue very long." (Wynn, Thomas & Coolidge, Frederick p. 111).

"Given what we know of Neandertal life and Neandertal corpse treatment, we think it unwise to equate Neandertal mortuary activities with modern human mortuary ceremonialism. There are clear differences in scale and content. Neandertal corpse treatment suggests actions to mitigate the emotional and social impact of death for the very short term. Large-scale rituals in which the entire community took part and which realigned and reinforced social links are just not in evidence. Nor do there appear to have been any religious or symbolic components. At most, Neandertals may have had some notion of continuance after death, but it was not one that affected the living for more than a short time." (Wynn, Thomas & Coolidge, Frederick p. 111).

Life Histories & Average Lifespan

"…there is nothing that we know about Neandertal life history that appears very different from ours: they didn't develop much faster, and they didn't reach reproductive age much earlier." (Wynn, Thomas & Coolidge, Frederick p. 80).

“In the absence of contrary evidence, this further supports the prediction that Neanderthals and modern humans shared equally prolonged childhoods. If so, as noted previously, they probably shared equally prolonged lifespans since age at sexual maturity and longevity are closely correlated across the mammals. However, skeletal age determinations have so far failed to reveal any Neanderthals who lived beyond their mid-forties, and wear seriation of dentitions suggest that compared to their early Upper Paleolithic successors, Neanderthals died much more often in young adulthood...The proposed elevated rate of young adult Neanderthal mortality is puzzling since it would have significantly exceeded the rate in historic hunter-gatherers, in Japanese macaque monkeys, and in chimpanzees...In sum then, pending the accumulation of contrary observations, it seems reasonable to hypothesize that childhood and lifespan were extended in Neanderthals more or less as they are in living humans. Future research may show that Neanderthals and living humans inherited their shared life history from Homo heidelbergensis, their last shared ancestor at 600-500 ka.” (Klein, Richard G. p. 583).

“A new study of the fossilized teeth of eight Neanderthal children found that their permanent teeth grew significantly faster and erupted earlier than those of our own species, Homo sapiens. Taken with other recent studies, the new data suggest Neanderthal kids may have reached adulthood a few years faster than modern humans....They found that it took the Neanderthals 2.5 years to form their first molar crowns, compared with three years on average in modern humans. Second molars appeared by age 8 in Neanderthals, and 10 to 12 years on average in

modern humans. This suggests that Neanderthals reached adulthood a few years earlier than modern humans" (Gibbons, Ann).

"Smith says Neanderthals reached full maturity by age fifteen, three to five years earlier than us…evolution apparently began to favor Neanderthal children who grew up faster, could bear children sooner, and reached adult size and strength as rapidly as possible to replace the older members of the troop who passed on so quickly." (Walter, Chip p. 126).

"Neanderthals lived faster than we did and they died younger, and possibly therein lies the reason we remain and they don't. Though they, too, were neotenic and time has also been genetically rearranged for them so that they were born earlier and remained younger longer than today's chimpanzees, gorillas, and orangutans, their childhoods were not as long as ours. This gave their brains less time to shape their personal experience, their ideas, and their personalities before they began to grow more rigid. And growing more rigid, they may have been a less childlike species, less prone to experiment. That would have made them less adaptable…Their minds may have been as sharp, but not as plastic, as those of Homo sapiens who had recently migrated out of Africa." (Walter, Chip p. 152-153).

The Quotes Above Referred to the Following Study:
http://www.pnas.org/content/early/2010/11/08/1010906107.full.pdf+html.

"We find that most Neanderthal tooth crowns grew more rapidly than modern human teeth, resulting in significantly faster dental maturation. In contrast, Middle Paleolithic H. sapiens juveniles show greater similarity to recent humans. These findings are consistent with recent cranial and molecular evidence for subtle developmental differences between Neanderthals and H. sapiens. When compared with earlier hominin taxa, both Neanderthals and H. sapiens have extended the duration of dental development. This period of dental immaturity is particularly prolonged in modern humans." (Smith, Tanya M. et. al.).

"...in the largest sample of Neanderthal and fossil Homo sapiens juveniles studied to date...maxillary M3 initiation in the Scladina juvenile occurred at 5.9 y (13), which is 2 to 4 years earlier than average mandibular M3 initiation ages in recent humans." (Smith, Tanya M. et. al.).

"...the findings that recent humans show significantly slower dental maturation than Neanderthals appears to be robust...available evidence suggests that consistently prolonged dental development may have first appeared in Homo sapiens." (Smith, Tanya M. et. al.).

"Some have argued that harsh conditions created high young adult mortality rates in Neanderthals, which may have acted as a selective pressure to maintain a rapid maturation pattern...Although additional study is necessary to assess the adaptive significance of developmental variation..." (Smith, Tanya M. et. al.).

Adult & Infant Mortality Rates

"That Neanderthal infant mortality was high --this is quite evident from the skeletal record-- should not be surprising." (Mithen, Steven J. p. 240).

“Few Neandertals seem to have survived beyond their peak reproductive years. Trinkaus concludes that disproportionate numbers of Neandertals died before reaching the age of 40...around 80% of all known Neandertal individuals appear to have died as young adults.” (Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. p. 1155).

“...skeletal age determinations have so far failed to reveal any Neanderthals who lived beyond their mid-forties....Neanderthals died much more often in young adulthood.” (Klein, Richard G. p. 583).

"With a high mortality rate and few survivors past the age of forty, Neandertal families extended to no more than three generations." (Wynn, Thomas & Coolidge, Frederick p. 20).

Cared for the old & sick

“...group concern for the old and sick may have permitted Neanderthals to live longer than any of their predecessors, and it is the most recognizably human, nonmaterial aspect of their behavior that can be reasonably inferred from the archaeological record.” (Klein, Richard G. p. 585).

Disease

“…all of the adult Neandertals at Shanidar suffered from degenerative joint disease in the knees, in the shoulders and elbows, in the ankles and feet, and in the back…The Shanidar Neandertals acquired their arthritic joints from constant, heavy exercise…The Shanidar Neandertals were not an aberration. The pattern of injury and degenerative joint disease presented by their skeletons is repeated wherever Neandertals are found…” (Wynn, Thomas & Coolidge, Frederick p. 17-18).

“...the skeletons of older Neanderthals often exhibit healed fractures of the skull or limbs, degeneration of the joints, advanced osteoarthritis of the vertebral column, and periodontal disease.” (Klein, Richard G. p. 584).

Tooth Health & Disease - possible links to Diet

“The Neanderthals (230,000-30,000 BP) show a high prevalence of enamel hypoplasias, antemortem tooth loss, periodontal disease and abscesses but dental caries is very rare among them. Six cases of dental caries (0.48%) have been reported among the approximately 1250 known Neanderthal teeth. The presence of caries in Neanderthals suggests the existence of

pathogenic dental plaque and dietary conditions compatible with the consumption of some cariogenic carbohydrates despite the hunter-gatherer lifestyle and cold climate existing during the Middle Paleolithic." (Lanfranco, Luis Pezo & Eggers, Sabine p. 6).

Based upon the genetic analysis of the plaque of five Neanderthals, the Neanderthals' oral microbiota included species known to cause caries and periodontal disease.: "We identified the caries-associated species Streptococcus mutans (0.08%–0.18%) and the members of the 'red complex' associated with modern periodontal disease (Porphyromonas gingivalis, 0–0.52%; Tannerella forsythia, 0.05–2.4%; and Treponema denticola, 0–1.87%), consistent with evidence of dental caries and periodontal disease in Neanderthals." (Weyrich et al. 2017).

"Starch residues preserved in dental calculus provide direct evidence that Neanderthals consumed cooked carbohydrate-rich foods (34, 35). Despite this, Paleolithic modern humans and Neanderthals have a low prevalence of caries (36). Caries are present in semisedentary Natufian hunter-gatherers from the Levant populations whose diet included wild cereals prepared using grindstones....The lower rates of caries in earlier and contemporaneous human groups may indicate a lesser reliance on foods rich in fermentable carbohydrates, but may also reflect a difference in bacterial virulence or changes in the pattern and likelihood of transmission between infected and uninfected individuals." (Humphrey, Louise T. et. al. p. 958).

"High caries rates are associated with sedentary food-producing societies that rely on foods rich in fermentable carbohydrates as staples. Frequencies of carious lesions in archaeological populations range from 2.2–48.1% of teeth for agricultural populations, but only 0–14.3% for hunter-gatherers." (Humphrey, Louise T. et. al. p. 954).

"Neandertal dental and alveolar remains have been noted for their elevated levels of dental enamel hypoplasias, the presence of ante-mortem tooth loss, the occasional incidence of periodontal inflammation and associated alveolar resorption and abscesses, and the rarity of dental caries." (Trinkaus, Erik; Smith, Richard J.; Lebel, Serge).

"Unlike modern urban humans with a soft refined diet and consequent rampant dental pathology, especially dental caries and periodontal disease, dental and alveolar pathology was relatively rare in Pleistocene humans. This holds true for the Neandertals. Among Neandertals, the most general observations of the dentition are a high level of occlusal and interproximal attrition**. The wear tended to be greater on the anterior teeth, frequently resulting in complete crown removal of some teeth by the fifth decade of life, and was accompanied by supereruption of the teeth. Caries lesions have been documented, but they were extremely rare (4 out of >1250 teeth or ~0.3%). Ante mortem tooth loss was present but rare, even in cases of marked occlusal attrition. The few known alveolar abscesses were associated with severe attrition and/or ante mortem tooth loss, and pathology of the mandibular body beyond alveolar lesions is unknown." (Walker, M.J. et. al.).

**Note: attrition is the wearing away of the biting surface of teeth as a result of grinding teeth or chewing abrasive foods.

"...the prevalence [of caries among Neanderthals] is very low, even compared with that in high-latitude recent populations living on pre-industrial unrefined diets." (Walker, M.J. et. al.).

"...they [caries] have rarely been documented in western Eurasian Neandertals." (Walker, M.J. et. al.).

"It may be significant that the Neandertal teeth with carious defects, as well as the early modern human ones, come from sites near the Mediterranean...The presence of these lesions among the southerly, but apparently not among more northerly, Late Pleistocene Neanderthals and Middle Paleolithic modern humans suggests a climatic correlation. Perhaps the greater availability in warmer climates of fruits and sugar-rich plant organs contributed to a higher (but still exceptionally low) prevalence of caries lesions." (Walker, M.J. et. al.).

"Alveolar lesions, ante mortem tooth loss, and orthodontic problems, as well as caries lesions, remain rare, in the context of high levels of occlusal and interproximal attrition, dental supereruption, and calculus accumulation. This implies a level of oral health rarely seen in more recent, sedentary human populations without routine dental care." (Walker, M.J. et. al.).

Neanderthal Extinction

"Did Modern Humans outcompete the Neanderthals?"
"The demise of Neandertals is one of the most debated issues in paleoanthropology." (Villa, P. & Roebroeks, W.).

"The disappearance of the archaic populations, including Neandertals, is routinely explained in terms of the "superiority" of modern humans, who had developed in Africa the ability to evolve complex cultural traditions and had become equipped with cognitive capacities which allowed them to expand globally and replace all other hominins...superiority in a wide range of domains, either in Africa and/or upon arrival of Homo sapiens in the Neandertal geographical ranges. These include inventiveness and capacity for innovation [11], [28], complex symbolic and linguistic abilities [29], [30], more efficient hunting strategies [31], exploitation of a broader range of resources including plants and aquatic ones [32], projectile technology [33]–[35], heat treatment of lithic raw materials [36], hafting technology [37], [38], planning capacities including larger scale social networks as shown by large transport distances of raw materials [39], environmental flexibility [40], memory capacity [41] as well as larger population sizes [42]. Inferiority in one or more of these domains has been at the core of many explanations for the demise of the Neandertals." (Villa, P. & Roebroeks, W.).

"For some authors replacement and supposedly rapid extinction of Neandertals can be explained only in terms of substantial cognitive, technological and demographic differences

between the Neandertals and AMH [42], [131]. But, as we tried to show here, the Neandertal archaeological record was not different enough to explain their demise in terms of inferiority in archaeologically visible domains. Thus, if Neandertals were not technologically and cognitively “disadvantaged”, how can we explain that they did not survive?” (Villa, P. & Roebroeks, W.).

Neanderthals may have assimilated into the modern human population rather than becoming extinct: “Because Neanderthal numbers were low to begin with, Riel-Salvatore said, it was easy for them and their genomes to seemingly disappear into the populations of more modern humans.” (Kaufman, Marc).

“Genetic studies now suggest that the debate on the demise of the Neandertals needs to be reframed in terms of some degree of interbreeding [23], [48], [49]. In that sense, Neandertals did not go extinct, even though their distinctive morphology did disappear.” (Villa, P. & Roebroeks, W.).

“Having thrived in Eurasia for more than 300,000 years, Neandertals vanished from the record around 40,000 years ago, when modern humans entered Europe. Modern humans are usually seen as superior in a wide range of domains, including weaponry and subsistence strategies, which would have led to the demise of Neandertals. This systematic review of the archaeological records of Neandertals and their modern human contemporaries finds no support for such interpretations, as the Neandertal archaeological record is not different enough to explain the demise in terms of inferiority in archaeologically visible domains. Instead, current genetic data suggest that complex processes of interbreeding and assimilation may have been responsible for the disappearance of the specific Neandertal morphology from the fossil record.” (Villa, P. & Roebroeks, W.).

“The high coverage genome of the Altai Neandertal [49] also suggests low genetic diversity which could indicate small population sizes (see Text S1 Hypothesis 8 for archaeological data). These genetic data suggest that differences in population sizes between the “resident” Neandertals and incoming AMH populations may have been a contributing factor in the absorption of Neandertal populations[23].” (Villa, P. & Roebroeks, W.).

References

Allen, John S. “The Omnivorous Mind: Our Evolving Relationship with Food.”Cambridge, Massachusetts & London, England: Harvard University Press, 2012.

Baumer, Christoph. “The History of Central Asia: The Age of the Steppe Warriors.” New York, N.Y.: I.B. Tauris, 2012. 372 pp.

Bocherens, Herve. “Ch 8. Diet & Ecology of Neanderthals: Implications from C and N Isotopes.” Neanderthal Lifeways, Subsistence and Technology: One Hundred Fifty Years of Neanderthal Study. Eds. Nicholas J. Conard & Jurgen Richter. Springer, Feb 2011. 308 pp.

Callaway, Ewen. “Modern human genomes reveal our inner Neandertal.” Nature News.29 Jan 2014. Web.

Cartmill, Matt; Brown, Kaye B.; Smith, Fred H. (Sept 2011). “The Human Lineage.” Hoboken, New Jersey: John Wiley & Sons, 624 pp.

Colonese, A.C. et. al. (July 2011). “Marine mollusc exploitation in Mediterranean prehistory: An overview.” Quarternary International. 239(1-2), pp. 86-103.

Cortés-Sánchez, Miguel et. al. (2011). "Earliest Known Use of Marine Resources by Neanderthals." PloS one, 6(9), p. e24026.

Costamagno, Sandrine. "13. Bone Grease Rendering in Mousterian Contexts: The Case of Noisetier Cave (Frechet-Aure, Hautes-Pyrenees, France)." Jamie L. Clark & John D. Speth (eds.). Zooarchaeology & Modern Human Origins. Vertebrate Paleobiology & Paleoanthropology, 2013.

D'Anastasio, Ruggero; Wroe, Stephen; Tuniz, Claudio; Mancini, Lucia; Cesana, Deneb T. et. al. (2013). "Micro-Biomechanics of the Kebara 2 Hyoid & Its Implications for Speech in Neanderthals." PLoS ONE. 8(12): e82261.

Dutchen, Stephanie. “Neanderthals’ DNA legacy linked to modern ailments.” Harvard Gazette. Jan 29, 2014.

Ecker, M. et. al. (2013). “Middle Pleistocene ecology and Neanderthal subsistence: Insights from stable isotope analyses in Payre (Ardèche, southeastern France).” Journal of Human Evolution. XXX. pp. 1-11.

Estalrrich, Almudena; Rosas, Antonio. (March 2015). “Division of labor by sex and age in Neandertals: an approach through the study of activity-related dental wear.” Journal of Human Evolution. Vol. 80, pp. 51-63.

Frayer, David. “The Science and Art of Neandertal Teeth [Slide Show].” Scientific American. Feb 2012.

Ferentinos, George et. al. (July 2012). “Early Seafaring Activity in the Southern Ionian Islands, Mediterranean Sea.” Journal of Archaeological Science. 39(7), pp. 2167-2176.

Friedmann, Theodore; Dunlap, Jay C.; Goodwin, Stephen F. “Advances in Genetics, Vol. 76.” San Diego, CA: Elsevier, 2011.

Gallagher, Andrew. “Absolute & relative endocranial size in Neandertals and later Pleistocene Homo.” HOMO -- Journal of Comparative Human Biology. May 23, 2014.

Gaudzinski, Sabine & Roebroeks, Wil. (2000). "Adults only. Reindeer Hunting at the Middle Palaeolithic site Salzgitter Lebenstedt, Northern Germany." Journal of Human Evolution. 38(4), pp. 497-521.

Gibbons, Ann. “Teeth suggest Neanderthals reached adulthood faster.” The Washington Post - Science News. Nov. 22, 2010. Online. <http://www.washingtonpost.com/wp-dyn/content/article/2010/11/22/AR2010112204883.html>.

Hardy, Bruce L. (March 2010). “Climatic Variability and plant food distribution in Pleistocene Europe: Implications for Neanderthal Diet & Subsistence.” Quaternary Science Reviews. 29(5-6), pp. 662-679.

Hardy, Karen et. al. (2012). “Neanderthal Medics? Evidence for food, cooking, and medicinal plants entrapped in dental calculus.” Naturwissenschaften. Vol. 99, pp. 617-626.

Hardy, Karen; Buckley, Stephen; Huffman, Michael. (9/1/2013). “Neanderthal Self-Medication in Context.” Antiquity. 87(337), p. 873.

Harris, Judith R. (2006). "Parental Selection: A Third Selection Process in the Evolution of Human Hairlessness & Skin Color." Medical Hypotheses. Vol. 66, pp. 1053-1059.

Hart, Donna & Sussman, Robert W. "Man the Hunted: Primates, Predators, and Human Evolution." Boulder, CO: Westview Press, a Member of the Perseus Books Group, 2009. 357 pp.

Helmuth, H. (Oct 1998). "Body height, body mass, and surface area of the Neandertals." Zeit schrift fur Morphologie und Anthropologie. 82(1), pp. 1-12.

Henry, Amanda G.; Brooks, Alison S.; Piperno, Dolores R. (April 2014). “Plant foods and the dietary ecology of Neanderthals and early modern humans.” Journal of Human Evolution. Vol. 69, pp. 44-54.

Henry, Amanda G. & Brooks, Alison S.; Piperno, Dolores R. (Jan 11 2011). "Micro-fossils in calculus demonstrate consumption of plants & cooked foods in Neanderthal diets." Proceedings of the National Academy of Sciences of the United States of America (PNAS). 108(2), pp. 486-491.

Henry, Amanda G. & Wood, Bernard. “Ch 2: Whose Diet? - An Introduction to the Hominin Fossil Record.” Evolution of the Human Diet: The Known, the Unknown, and the Unknowable. Ed. Ungar, Peter S. New York, N.Y.: Oxford University Press, 2007.

Hlusko, Leslea J. et. al. (July 2013). “Neanderthal Teeth from Moula-Guercy, Ardeche, France.” American Journal of Physical Anthropology. 151(3), pp. 477-491.

Humphrey, Louise T. et. al. (Jan 2014). “Earliest evidence for caries and exploitation of starchy plant foods in Pleistocene hunter-gatherers from Morocco.” PNAS. 111(3), pp. 954-959.

Johanson, Dr. Donald; Wong, Kate. “Lucy’s Legacy: The Quest for Human Origins.” New York, N.Y.: Random House LLC, Mar 2009.

Kaufman, Marc. “Anthropologists adopt a more favorable view of Neanderthals.” The Washington Post. Oct 2010.

Klein, Richard G. “The Human Career & Human Biological & Cultural Origins, 3rd ed.” Chicago & London: The University of Chicago Press, 2009. 989 pp.

Krueger, Kristin L.; Ungar, Peter S. (2012). “Anterior Dental Microwear Texture Analysis of the Krapina Neanderthals.” Cent. Eur. J. Geosci. 4(4). pp. 651-662.

Kusimba. “African Foragers.” Lanham, MD: Alta Mira Press, a division of Rowman & Littlefield Publishers, Inc., 2003.

Lanfranco, Luis Pezo & Eggers, Sabine. (May 14, 2012). “1. Caries Through Time: An Anthropological Overview.” Contemporary Approach to Dental Caries. Ed. Dr. Ming-Yu Li. InTech. 488 pp. ISBN: 978-953-51-0305-9.

Le Cabec, Adeline et. al. (March 2013). “Anterior tooth root morphology and size in Neanderthals: Taxonomic & functional implications.” Journal of Human Evolution. 64(3), pp. 169-193.

Lieberman, Daniel. “The Story of the Human Body: Evolution, Health, & Disease.” Random House LLC, Oct 2013. 480 pp.

Lozano, Marina et. al. (Oct 2013). “Toothpicking and Periodontal Disease in A Neanderthal Specimen from Cova Forada Site (Valencia, Spain).” PLoS ONE. 8(10): e76852.

Madella, Marco et. al. (2002). “The Exploitation of Plant Resources by Neanderthals in Amud Cave (Israel): The Evidence from Phytolith Studies.” Journal of Archaeological Science. Vol. 29, pp. 703-719.

Marean, Curtis W. "Neanderthal Meat & Fat Storage & Fat Rendering." Reply Message to Rebecca Cox. 11 Feb 2014. E-mail.

Marean, Curtis W. & Assefa, Zelalem. (1999). "Zooarcheological Evidence for the Faunal Exploitation Behavior of Neandertals & Early Modern Humans." Evolutionary Anthropology. 8(1), pp. 22-37.

Massachusetts Institute of Technology. “Did Neanderthals eat their vegetables? First Direct Evidence of Plants in Neanderthal Diet.” Science Daily. June 25, 2014. <www.sciencedaily.com/releases/2014/06/140625201908.htm>.

Mithen, Steven J. "The Singing Neanderthals: The Origins of Music, Language, Mind & Body." Harvard University Press, 2005. 374 pp.

Naito, Y.I. et. al. (2016). “Ecological niche of Neanderthals from Spy Cave revealed by nitogen isotopes of individual amino acids in collagen.” Journal of Human Evolution. 93, 82-90.

New World Encyclopedia contributors, "Neanderthal," New World Encyclopedia, Accessed 5/25/2014. <http://www.newworldencyclopedia.org/p/index.php?title=Neanderthal&oldid=978830>.

O’Neil, Dennis. “Evolution of Modern Humans: Neandertals.” Palomar College. Accessed 5/25/2014. <http://anthro.palomar.edu/homo2/mod_homo_2.htm>.

Phillips, Dave. (2000). “Neanderthals Are Still Human!” Acts & Facts. 29(5). <http://www.icr.org/article/neanderthals-are-still-human/>.

Price, T. Douglas. “Europe Before Rome: A Site-by-Site Tour of the Stone, Bronze, and Iron Ages.” New York, N.Y.: Oxford University Press, Feb 2013. 408 pp.

Reeve, Eric C.R. “Encyclopedia of Genetics.” New York, N.Y.: Routledge, Jan 2014. 972 pp.

Rendu, William; Costamagno, Sandrine; Meignen, Liliane; Soulier, Marie-Cecile. (2012). "Monospecific faunal spectra in Mousterian contexts: Implications for social behavior." Quarternary International. Vol. 247, pp. 50-58.

Richards, M.P. & Taylor G. et. al. (2008). “Isotopic Dietary Analysis of a Neanderthal & Associated Fauna from the site of Jonzac (Charente-Maritime), France.” Journal of Human Evolution. Vol. 55, pp. 179-185.

Roebroeks, Wil ed. “Guts & Brains: An Integrative Approach to the Hominin Record.” Leiden University Press, 2007.

Roebroeks, Wil & Villa, Paola. (March 29, 2011). "On the earliest evidence for habitual use of fire in Europe." Proceedings of the National Academy of Sciences of the United States of America (PNAS). 108(3), pp. 5209-5214.

Sandgathe, DM; Dibble, HL; Goldberg, P; McPherron, SP; Turq, A; Niven, L; Hodgkins, J. (2011). "On the Role of Fire in Neandertal Adaptations in Western Europe: Evidence from Pech de l'Aze IV and Roc de Marsal, France." PaleoAnthropology. 2011: pp. 216-242.

Sankararaman, Sriram et. al. (20 March 2014). “The genomic landscape of Neanderthal ancestry in present-day humans.” Nature. 507(7492), pp. 354-357.

Sawyer, G.J. & Maley, Blaine. (2005). "Neanderthal Reconstructed." The Anatomical Record (Part B: New Anatomy). 283B. pp. 23-31.

Shipman, Pat. "Separating 'us' from 'them': Neanderthal & modern human behavior." Proceedings of the National Academy of Sciences. 105(38), pp. 14241-14242.

Sistiaga, Ainara et. al. (June 25, 2014). “The Neanderthal Meal: A New Perspective Using Faecal Biomarkers.” PLoS ONE. 9(6): e101045. doi:10.1371/journal.pone.0101045.

Smith, Tanya H. et. al. (Nov. 2010). “Dental Evidence for Ontogenetic Differences between Modern Humans & Neanderthals.” Proceedings of the National Academy of Sciences of the United States of America. Online. <http://www.pnas.org/content/early/2010/11/08/1010906107.full.pdf+html>.

Smithsonian National Museum of Natural History. “Homo neanderthalensis.” What does it mean to be human? Site last updated 01/03/2014. Accessed 01/08/2014. <http://humanorigins.si.edu/evidence/human-fossils/species/homo-neanderthalensis>.

Smithsonian National Museum of Natural History. “Homo neanderthalensis - Key Fossils - La Chapelle-aux-Saints; La Ferrassie; Shanidar 1.” What does it mean to be human?

Site last updated 01/03/2014. Accessed 01/08/2014. <http://humanorigins.si.edu/evidence/human-fossils/species/homo-neanderthalensis>.

Spanish National Research Council (CSIC). "Neanderthal groups based part of their lifestyle on sexual division of labor." ScienceDaily, 18 February 2015. <www.sciencedaily.com/releases/2015/02/150218123427.htm>.

Speth, John D. (2013). "3. Middle Paleolithic Large-Mammal Hunting in the Southern Levant." Zooarchaeology & Modern Human Origins, Vertebrate Paleobiology & Paleoanthropology. pp. 19-43.

Speth, John D. & Tchernov, Eitan. "Chapter 3: Neanderthal Hunting & Meat-Processing in the Near East." Meat Eating & Human Evolution. Eds. Craig B. Stanford & Henry T. Bunn. Oxford University Press, May 2001. 384 pp.

Stringer, C.B. et. al. (Sept 2008). "Neandertal exploitation of marine mammals in Gibraltar." Proceedings of the National Academy of Sciences. 105(38), pp. 14319-14324.

Switek, Brian. “Much Earlier Split for Neanderthals, Humans?” National Geographic Daily News. Oct 21 2013.

Trinkaus, Erik; Smith, Richard J.; Lebel, Serge. (2000). “Dental Caries in the Aubesier 5 Neandertal Primary Molar.” Journal of Archaeological Science. Vol. 27, pp. 1017-1021.

University of Adelaide. (2017, March 8). Dental plaque DNA shows Neanderthals used 'aspirin'. ScienceDaily. Retrieved March 9, 2017 from www.sciencedaily.com/releases/2017/03/170308131218.htm

University of New England. "Talking Neanderthals challenge the Origins of Speech." Science Daily. March 2, 2014. <http://www.sciencedaily.com/releases/2014/03/140302185241.htm>.

University of Washington. "Neanderthal lineages excavated from modern human genomes." ScienceDaily. 29 January 2014. <www.sciencedaily.com/releases/2014/01/140129134958.htm>.

Villa P, Roebroeks W (2014) Neandertal Demise: An Archaeological Analysis of the Modern Human Superiority Complex. PLoS ONE. 9(4): e96424. doi:10.1371/journal.pone.0096424.

Walker, M.J. et. al. (April 2011). “New Evidence of Dental Pathology in 40,000 Year Old Neandertals.” Journal of Dental Research. 90(4), pp. 428-432.

Walter, Chip. "Last Ape Standing: The Seven-Million-Year Story of How and Why We Survived." New York, N.Y.: Walker & Company, 2013.

Weyrich, L.S. et al. (2017). Neanderthal behavior, diet and disease inferred from ancient DNA in dental calculus. Nature. doi: 10.1038/nature21674

WiBing, C. et. al. (2015). “Isotopic Evidence for Dietary Ecology of Late Neanderthals in North-Western Europe.” Quaternary International.

Wong, K. (02/2005). "The littlest human." Scientific American. 292(2), pp. 56-65.

Wrangham, Richard. “Ch 16: The Cooking Enigma.” Evolution of the Human Diet: The Known, the Unknown, and the Unknowable. Ed. Ungar, Peter S. New York, N.Y.: Oxford University Press, 2007.

Wikipedia Online Encyclopedia. “Denticulate Tool” Accessed 1/6/2014. <http://en.wikipedia.org/wiki/Denticulate_tool>.

Wikipedia Online Encyclopedia. “Gibraltar.” Accessed 3/13/2014. <http://en.wikipedia.org/wiki/Gibraltar>.

Wikipedia, the Free Online Encyclopedia. “Neanderthal Behavior.” Accessed 6/26/2014. <http://en.wikipedia.org/wiki/Neanderthal_behavior#Tools>.

Wynn, Thomas & Coolidge, Frederick L. "How to Think Like a Neandertal." New York, N.Y.: Oxford University Press, 2012.