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The Dead Actually Tell Many Tales: How Archaeologists Have Used Scientific Analysis to Study Scandinavian Burials

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Abstract
Archaeologists often employ techniques from scientific fields to better analyze historical and prehistorical sites. Here we explore how developments in scientific analysis have changed and improved our understanding of past societies. With a specific focus on the study of Scandinavian burials, we review the history of Scandinavian archaeology and how the field is constantly changing as a result of new and more nuanced analysis. From the Bronze Age to the Viking Age, we analyze how new information challenges previous assumptions about Scandinavian societies.

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Scandinavian burials, bioarchaeology, scientifc analysis, Vikings

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Olav, the late village chieftain, lies on a wooden raft. Surrounded by his most favored possessions and his sword, he is sent off into the water by his inept brother, Orm. As Orm struggles to light the craft on fire via flaming arrow, his warrior wife Frøya shares an exasperated glance with compatriot Arvid, while the other townspeople attempt to remain serious. Arvid begs Orm to let him shoot the arrow so that the chieftain can enter Valhalla, only to be denied. "Don't *boo* your chieftain! Have any of you ever tried to fire an arrow with really frozen fingers?" Orm asks of the crowd, to which everyone raises their hand.

The scene is from *Norsemen* (*Netflix*), a satirical parody of the drama-filled *Vikings* TV show (*History,* 2013). Filmed in both Norwegian and English, the show takes place in a small Norwegian community in 709 AD. While warrior Arvid tries to settle down on a farm after years of raiding (which he won by cleaving the village's most successful farmer in half), Olav is fatally wounded by an enemy chieftain. Orm, seeking his chance to become chieftain, kills his brother at his most vulnerable state—literally minutes after Arvid had reached inside Olav's chest cavity to check for a beating heart. Again, satire is a prominent theme in the show.

But while much of the dialogue and plot are centered around the humorous personalities and misdeeds of the main characters, *Norsemen* is not completely incorrect in its representation of Viking Age Scandinavia. And while it may seem counterproductive to study dead people, much of this information has been determined through the study of Viking Age burials, not written records. The world has had a long history of infatuation with the Vikings, from the idyllic wild-yet-civilized stereotypes in the late 19th - and early 20th-centuries, to caricatures of burly blond men in horned helmets belting out opera lyrics, to the recent resurgence of Norse mythology in pop culture. These changes in public perception have largely been driven by advancements in knowledge from and reinterpretations of Viking Age burial sites, all of which have been made possible with the application of methods of scientific analysis.

Archaeology enjoys a largely beneficial relationship with the “hard” sciences, such as biology, chemistry, and geology. Archaeologists often use tools and analytical techniques from these fields to better analyze the sites they are excavating, extracting data that may not be initially evident. These techniques are valuable in allowing archaeologists to better interpret the cultures they study, particularly when there is little or no written history to provide a basic platform for interpretation. One particular field of study that has undoubtedly benefited from the advancements of scientific analytical techniques is the study of ancient Scandinavian burials.

The advancements in analytical techniques used in archaeological studies can be traced through the last two centuries, with an increasing involvement in interpretation. In the last fifty years, excavations of Viking Age burials assisted with scientific techniques have driven a reconfiguration of how we characterize Viking Age Scandinavia. In the following pages, we will first explore the variety of scientific methods used in archaeology: what are some common methods used in the field, when where they developed, and how have these methods helped us access the past? We will then narrow our focus to Scandinavian burial archaeology and analyze how the increasing involvement of scientific analysis in the field has corrected previous misconceptions made by early Scandinavian archaeologists. Finally, we will address the role scientific analysis has played in reinterpreting Viking Age Scandinavia. As scientific analysis has made more information available to researchers, archaeologists have shifted the public understanding of Viking Age Scandinavia from one of racially pure savages to a highly nuanced perspective of a culturally diverse region and time period.

Scientific Analysis in Archaeology

The advent of the union between scientific analysis and archaeology can be dated nearly back to the birth of archaeology itself. Even before 1800, a number of contemporary scientists had published qualitative analyses of the compositions of ancient metal alloys and pigments. Although compositional analysis never became a raging topic in 19^{th} century academic journals, chemists maintained a slow but relatively steady study of ancient metal alloys. According to Earle R. Caley, the first excavation to be conducted with "the correct scientific principles" occurred in 1875 at Olympia (Caley 1955, 64). From this point onwards, chemical analysis as a tool for archaeological analysis began to bloom: scientists such as Helm and Carnot studied organic compounds and the fluorine content of ancient human skeletons, respectively, while others developed applications of chemical procedures to artifact preservation. According to Caley's personal records, of the total number of chemical archaeology papers published since 1800, more than 30% were published between 1955 and 1967 (Caley 1967).

Today, the most commonly known analytical technique used in archaeology is radiocarbon dating. Proposed in 1946, radiocarbon dating has been modified and corrected numerous times since, the most recent occurring in March of this year. The method, which measures the decomposition of the chemically-unstable ^{14}C isotope in organic materials, can be used to date objects up to 50,000 years old. While this form of dating is considered to be *absolute,* though, it has not always been *accurate*. Researchers have developed numerous improvements to the precision of the dates and the range of materials that can be dated. In 1970, R. Longin proposed a method for collagen extraction from human bones, which both circumvented the issue of missing site-related artifacts, and opened the door to more reliable dating of the skeleton rather than relying on artifacts that may not be contemporary to the site

(Longin 1970). A standard calibration curve derived from dendrochronology (tree-ring calibration) was introduced in 1986 and continues to be updated, and more recently, a team of Danish scientists tested the viability of dating soil organic fractions (Manning *et al.* 2020; Kristiansen 2003). At Cornell University, Manning *et al.* discovered that a single calibration curve, developed in the Northern Hemisphere but applied globally, was resulting in substantial dating variations. By studying atmospheric carbon levels, the team determined that radiocarbon levels vary by region and are largely related to the growing seasons; from that they proposed more specific regional calibrations (Manning *et al.* 2020).

Although radiocarbon dating is a common tool for archaeologists everywhere, a plethora of other techniques are available from several scientific fields. From chemistry alone, archaeologists can study chemical composition, such as that of ancient pigments, using Raman spectroscopy, UV-Vis spectroscopy, X-Ray Fluorescence, High Performance Liquid Chromatography, infrared spectroscopy, mass spectroscopy, and microscopy (Oakley 2012). From biology, the development and study of genomics in the past twenty years has revolutionized the study of ancient remains (Zwart 2009). Geography has contributed numerous survey and imaging techniques that have allowed archaeologists to visualize sites that are no longer visible on the ground (Brooke 2018; Verhoeven 2017).

One important distinction that must be made in archaeology is the classification of skeletons and bones as archaeological specimens or forensic evidence. To do this, forensic specialists and archaeologists evaluate the post-mortem interval (PMI) of the skeleton. The issue that arises with finding the PMI comes from environmental conditions: fluctuations in temperature, body size, accessibility to insects, and site location can all affect the aging and decomposition process differently. Addressing this complication, Woess *et al.* evaluated the applicability of infrared (IR) microscopic imaging. Within the project, they found that certain techniques revealed an indicator of bone mineralization, which could be used to differentiate between archaeological bone samples and the more recent, less mineralized forensic samples (Woess *et al.* 2017).

X-Rays were first discovered in the late 19th century by Wilhelm Rongten, who won a Nobel Prize for his research in 1901. While the use of X-Rays in spectroscopy can be dated back to 1909, it did not become commercially available for elemental analysis until the 1950s. Since then, X-Ray Fluorescence (XRF) has become a staple tool in the belts of archaeologists, geoarchaeologists, and art conservationists. The value of this tool comes from its artifact-friendly applications: XRF is non-destructive, it requires minimal sample preparation, the process is fast and easy to use, and, importantly, is cost-effective (Shackley 2011). XRF is a method for the quantitative and qualitative analysis of chemical elements: what is in the sample, and how much?

With the completion of the Human Genome Project in 2003, genomics and bioinformatization have increasingly affected fields in both science and the humanities. Zwart defines bioinformatics as the "research, development, and application of computational tools for the use of biological, medical, behavioral health data" (Zwart 2009, 126), which he argues is having an impact on how we "define and understand ourselves, [and] how identities are formed and constituted" (125). According to some archaeologists, genomics has transformed what was originally archaeology into bioarchaeology—rather than analyzing artifacts, archaeologists focus on analyzing DNA fragments to understand the health and diets of ancient humans. While that may be taken as a negative or a positive, genomics in archaeology has undoubtedly allowed us to understand and reconstruct one of the most pivotal events in human history: the Neolithic revolution and the emergence of agriculture.

In the world of landscape archaeology, a sub-discipline that emerged in the mid-1970s, archaeologists study the "environmental and sociocultural variables influencing the mutual interaction of humans with their natural environment" (Verhoeven 2017, 3). In a technological union with the world of geology, one of the tools of landscape archaeologists is remote sensing. Originally used by archaeologists to locate sites, the method now provides techniques that can be used for landscape patterning—particularly when combined with other techniques, such as artifact survey, geochemical prospection, botany, and geology. Remote sensing itself is a fairly vague definition, covering any sensing (imaging, non-imaging, airborne, spaceborne, optical, non-optical, and so on) that occurs above the earth's surface. For archaeologists, though, this generally lends itself to Airborne Laser Scanning (ALS), which allows researchers to digitally remove the vegetation of an area and digitize surfaces with centimeter-level accuracy.

Another type of imaging that has proven valuable for archaeologists is thermal imaging (Brooke 2018). An even more recent development since the emergence of landscape archaeology, thermal imaging had meager beginnings in the 1990s with expensive technology that offered "poor spatial and radiometric resolution" (2). Since 2010, however, Brooke argues that developments in thermal imaging cameras has made the method far more accessible and useful. On a molecular level, objects, materials, and elements radiate a certain, unique amount of energy that is perceived as infrared radiation. Because of these energy emissions, an infrared camera can detect anomalies in historic buildings, as well as differentiate between building materials, making it a useful tool for the non-destructive study of historical and archaeologically-important man-made structures.

Why is this Important to Archaeological Interpretation?

Analytical tools, and their continuing improvements, such as the ones discussed above, have a major impact on our understanding of the past. The amount of information that can be gleaned from an excavation has increased exponentially with interdisciplinary communication.

Looking back to the original chemical analyses used in archaeology, the data provided did not amount to much. The 19th century was relatively limited when it came to studying things that could not be seen (such as DNA). To a certain extent, these metal composition analyses did not advance understanding of ancient communities any more than reading a Roman account of the Gauls helped Classical scholars better understand the nuances of Celtic culture. Qualitative studies of ancient coins did nothing to correct the prevailing theories of cultural evolution or white supremacy. That being said, however, interdisciplinary work has been ingrained into archaeology's origins, and that has allowed for continued developments to positively affect archaeological theory since.

In 1904, for example, an article titled "Ancient Russian Ornaments and Weapons" appeared in *The Antiquary* (Sheppard 1904). "The department of antiquities…has recently been enriched by a collection of primitive implements and ornaments of an exceptionally interesting nature," Sheppard writes (50). If that opening statement seems slightly morally ambiguous, that is because the entire situation was morally ambiguous. The artifacts were collected by a Russian museum curator at the tumulus "Efaefsk," and mysteriously passed hands to a "Mr. A. Reichdart," who was travelling through Russia at the time. The article provides a general description of the tumulus and the objects found, remarking that the grave goods (shockingly) bore "striking resemblance" to grave goods of other Russian burial mounds (51). If this excavation had occurred at the end of the 20th century, rather than the beginning, the analysis would have been vastly different. Chemical analyses of the metals and amber objects could have revealed object origin, the skeletons (of which there were “about fifteen”) would have been properly studied and identified, and the surviving hair sample probably could have been used for DNA analysis (51). Needless to say, these practices were not available at that time to study such “primitive” implements and ornaments.

Today, collaboration between fields is much more effective and important. As mentioned by Manning, the discovery of variability in atmospheric carbon could have major implications to the ordering of events in the past. The article from *Heritage Daily* about this age-correction goes into detail about the volcanic eruption on Santorini over three thousand years ago: originally, archaeologists had dated the explosion to 1500 BC, while scientists argued it should have been 1630-1600 BC. With the new calibration for the Mediterranean taken into effect, this date is shifted to 1600-1550 BC, which happens to coincide with other archaeological data and Egyptian records of the event (*Heritage Daily* 2020). Clearly, even as an absolute dating technique, radiocarbon dating contains nuances that may alter our understanding of the past. Nonetheless, it has opened many doors for archaeologists to study prehistoric sites and events.

To put it lightly, genomics has affected the world in an unprecedented way. Today, for a small fee, you can trace your family lineage with a quick cheek swab—in fact, biochemistry students are able to trace their own haplogroup as a laboratory exercise. Medical professionals can use mtDNA (DNA only passed down by the mother) to monitor predispositions to certain diseases. In addition to GenBank—the NIH genetic sequence database—massive research projects such as the Human Genome Diversity Project, HapMap, and the Genographic Project, provide new information on early human history and reopen archaeological debates. Preserved skeletons take on a new meaning with the developments of genomics: analyses of everything from migration patterns to ailments can be understood in a way that early archaeologists could only dream of (Zwart 2009). The infamous case of Otzi, the 5,300-year-old man found in the Alps, is an prime example of using DNA analysis for interpretation. Having been discovered in 1991, before the Human Genome Project had even been created, Otzi's entire genome was sequenced in 2012 (using a measly 20 *nanograms* of DNA sample). From the new information, researchers determined that his eyes had been brown, he had Lyme disease, and that he was lactose intolerant. More importantly, however, they were able to trace how his ancestors had likely migrated across Europe (Conger 2012). In 2016, researchers reconstructed Otzi's clothing using residual DNA, and in 2013, used modern genetics to trace 19 living male relatives in Europe (Lewis 2016; Ghose 2013).

A famous case in which scientific analysis played a major role was in western Pennsylvania in the 1970s. The excavations at Meadowcroft Rock Shelter, led by James Adovasio, forever changed American archaeology by challenging the longstanding Clovis First Theory. Before Meadowcroft, it was assumed that the Americas were rapidly populated by the Clovis culture period. The team at Meadowcroft, however, discovered artifacts radiocarbon dated to a period thousands of years before the Clovis culture. To create a soundproof case to prove the new theory of migratory patterns, Adovasio's team used as many scientific analysis techniques as possible. As Adovasio recounts in his book, the excavation used the most sophisticated techniques from "archaeology, history, paleoecology, geology, geomorphology, pedology, hydrology, climatology, and floral and faunal succession" (Adovasio 2003, 164). In result, a new theory of population was proposed, with ample scientific evidence to support it.

More recently, archaeologists have used aerial photography and satellite technology to locate a potential settlement of epic implications: Point Rosee in Canada.

In 1960, L'Anse aux Meadows was the first site to be confirmed as a Viking settlement in North America. This discovery was a bit like using water to quench a grease fire: while it answered longstanding theories about Vikings discovering North America long before Christopher Columbus, it also provided considerable fodder to conspiracy theorists. Thomas McGovern acidly addresses this issue in his article:

> The search for the Norse settlements of Vinland mentioned in *Eirik the Red's Saga* and the *Greenlander's Saga* has spawned a huge literature marred by many shoddy fakes and many speculative pipedreams apparently deriving from the psychological needs of white European immigrants for a politically and racially acceptable past divorced from the reality of Native American cultural diversity and complexity (McGovern 1990, 343).

If one site was discovered, who was to say that the Norse had not colonized the region? While folklore suggested more than one North American settlement, there was no evidence of Viking dominance in the Americas. In 2016, the University of Alabama collected infrared images of a site three hundred miles south of L'Anse aux Meadows. This second site, identified with potentially man-made shapes and discolored vegetation from four hundred miles away, provided evidence of higher-than-average iron readings, Viking-style turf walls, ash residue, and bog iron—all symptoms that point to a Viking settlement. The researchers developed a CGI representation of the site, which can be viewed on NOVA's website (Eck 2016). The site is still being studied, but this discovery suggests a higher presence of Scandinavian settlers than was previously estimated.

Historically, the use of scientific techniques in archaeology have contributed to numerous re-interpretations of theories that were once considered gospel. Interpretation undoubtedly remains the most important aspect of archaeology, as data cannot interpret itself, but data can also support or contradict archaeological theory. Without infrared imaging, for example, Point

Rosee might never have been discovered. Without the contemporary techniques used at Meadowcroft, those looking to dismiss the new theory could have easily negated the dates as incorrectly interpreted.

Using Scientific Analysis in Studying Ancient Scandinavian Burials

> "An hour had not passed before the ship, the wood, the girl, and her master were nothing but cinders and ashes" (Pearson 1999, 2).

In 922 AD, secretary of the embassy of Baghdad, Ibn Fadlan, recounted the funeral of a Viking leader he witnessed while in Volga (today's Bulgaria). According to the Arab scholar, the people honored their late king by first burying him in the ground for ten days while preparing the funeral, and then interring the king in a boat with a slave girl, animals, and his most prized possessions. After the ceremony was completed, the ship and all of its contents were burnt to the ground (Pearson 1999).

Considering the severe lack of written and personal accounts of Scandinavian practices—aside from monks recounting Viking raids—this piece appears to be a gold mine of information. But while this personal account sounds fantastical and highly valuable to scholars, no one can actually find the site of the funeral (particularly because everything was consumed with fire) to study it.

Scandinavia and the associated Northern Atlantic are, somewhat ironically, living museums of death. The people who lived in Scandinavia over the last five-thousand years or so practiced numerous forms of interment and burial, including, but not limited to: burial mounds, barrows, passage graves, boat burials, storage pit sacrifices, cremation or interment, mass graves, single graves, water graves, bogs, horse burials, and dolmens (Dreyer 1908; Holst 2001; Paulsson 2010; Pearson 1999). Within these forms of burial, many variables could be used symbolically. The shape or depth of a grave may have related to social status or gender, the grave could mimic a house or pit, and orientation of the interred could replicate the orientation of Viking longhouses, for example. The existence of grave goods and their past uses vary wildly in interpretation, particularly when the goods were cremated with the body (Pearson 1999).

Academic interest in ancient Danish burials can be traced back to the mid- to late-20th century. Dreyer argues that the first great advance in Danish archaeology was the creation of the three-age system by Thomsen and Sven Nilsson. The two scholars argued for the division of prehistoric Scandinavia into the Stone, Bronze, and Iron Ages—a classification that was heavily contested by the rest of the world. German archaeologists refused to believe that humans discovered the metal alloy before the pure element, thanks to the well-ingrained belief at the time that humans only culturally evolve to a more advanced and civilized society (Dreyer 1908). In the 1870s, this debate was closed with the help of a goldsmith. After visiting a museum in Copenhagen and learning about ancient metalworking, he went home to test out the techniques himself. Using the same bronze alloy composition that was used in the Bronze Age, the goldsmith decorated the metal with another bronze tool, proving that iron was not a necessary material during this time period. Thanks to minimal funding and the constant battles with German archaeologists, Danish archaeology remained a wild and lawless field well into the end of the 19th century. In 1886, for example, Dreyer himself found a kitchen-midden and explored it extensively before reporting the find to archaeologists, while he simultaneously lamented the fact that the best grave and bog goods were stolen and melted down in the previous century (526).

One particular case study that exemplifies the use and development of analytical techniques in reinterpreting the past presents itself in two "sister" articles: one published in *Antiquity*, the other in the *Journal of Archaeological Science* (Holst 2001; Breuning-Madsen 2001). The authors, from departments of prehistoric archaeology (Holst), geography (Breuning-

Madsen), and historical and archaeological research (Rasmussen) studied oak-log coffin burial mounds from South Scandinavia by reconstructing a scaled-down mound and studying the chemical processes that progressed as a method for understanding ancient Scandinavian practices. From the experiment, they determined how the burials were so well preserved, and that the ancient culture that practiced this type of burial did so with specific mound-building instructions (Holst).

Another development in the early 2000s from Scandinavian archaeology came from Kristiansen *et al.* (2003). This team, which included the aforementioned Holst, developed and tested a new method for radiocarbon dating the soil of burial mounds. Dating the soil of a burial is potentially useful for many reasons: it can provide dates for burials that lack any remaining organic matter, it is less destructive than excavating the entire burial site, and, when accurate, can provide a better time range for the burial than organic grave elements that may not have been contemporary to the burial. Building on a dating technique used since the 1980s, they tested the reliability of using organic matter from the soil to date the burial mounds. This method can be tricky and unsatisfactory, however, so Kristiansen *et al.* proposed dividing the soil organic matter (SOM) into fractions of similarly-composed elements by treating the SOM with different chemicals before ^{14}C analysis. This method of dating has the potential to be especially useful in Scandinavian archaeology, as South Scandinavia contains an estimated 100,000 prehistoric burial mounds constructed with sods turned upside-down, protecting the most carbon-valuable portion of the earth.

But while analytical methods have developed and corrected our understanding of the prehistoric past, it should not be considered the end-all-be-all of archaeology and interpretation. There is only so much data that can be extracted with radiocarbon dating and pH probes; at the end of the day, most of this information is meaningless without necessary cultural interpretation. Niels Skak-Nielsen plays the devil's advocate in this case, offering a poignant reinterpretation of grave daggers from the Late Neolithic/ Early Bronze Ages without the aid of scientific testing. Instead, after some consultation with a butcher, Skak-Nielsen proposes that the metal daggers found in graves and burials were not, as previously assumed, weapons of war, but rather a symbol of elitism, sacrifice, and social rank (Skak-Nielsen 2009).

A More Nuanced Understanding of Ancient Scandinavia

The effects of developments in Scandinavian archaeology have been interesting, to say the least. The three-age system alone, which Dreyer insists was the "light [from Denmark and Sweden] shone forth to far-off lands, where answering beams arose" (Dreyer 1908, 506), has made appearances in archaeology far away from where it was introduced. Whether or not they should (have), archaeologists have employed one or all of these classifications throughout Europe, Africa, Asia, and the Americas. The 19th century, however, as previously stated, was unhindered by organized research or reliable reporting. In an effort to prove the importance of Thomsen and Nilsson's classification, Dreyer can be found writing blithely racist statements, such as: "There are, of course, many races, including all of the Negro races of Africa, which have passed directly from stone to iron, but that was due to the fact that this metal was introduced while they were still in the Stone age" (509). Much of the research at the time was driven by the popular theory of cultural evolution, and from that, European archaeologists and anthropologists tried to apply European cultural changes to every community they studied.

From an excavation standpoint, research of burial sites was little more than a man with a shovel. Minimal effort was taken into studying the chemical compositions of the goods they found, with the exception of a few studies of metal alloys (Caley 1955). For example, while researchers knew that the metal pans that formed in some burial mounds were made of iron, no analysis was done on the clothing they found in those same burials. Were those materials native to the region, or were they trade goods? Sophus Muller developed a "reliable chronology" of the Stone age by comparing the shapes of graves and types of implements: he determined that graves began with square-chamber types, then "developed" into large "passage graves," and finally stone cists. Muller casually avoided the dolmens present, because "no research…was comprehensive enough to discover their real value" (Dreyer 1908, 512). Because scientific dating techniques did not exist yet, Muller created this relative timeline with grave shapes and grave goods. The issue that befalls this method, however, is that grave goods can be notoriously unreliable: some goods may have been dozens of years or even centuries older than the grave itself, or the goods may have been added centuries after the first burial.

Bettina Paulsson disagrees with Muller's chronology (Paulsson 2010). She argues, based on radiocarbon dates and the Bayesian model of analysis (a method that factors in the uncertainty of the dates), that the first passage graves were built in the 35th century BC. The chronological relationship between dolmens and passage graves is difficult to determine, but reliable dates for the use of dolmens begins in 3300 BC, with some evidence that they were even built before the passage graves. Long barrows, however, are now considered to be contemporary with dolmens, but older than passage graves. With a century separating these two archaeologists, and with a multitude of developments in the field since Muller, Paulsson was able to make corrections to previous assumptions.

As I have previously mentioned, one major example of archaeologists correcting previous mistakes with better analytical techniques are the oak-log coffin burials from the South Scandinavian Early Bronze Age. These burials, which consisted of a mound "core," characterized by a relatively wet environment, and a drier "mantle," were unusually well-preserved. The coffins buried in the core were, as the name implies, made from oak logs, and many contained skeletons that were still intact (Holst 2001). Dreyer remarks on the wealth of information available in the oak coffins, such as "the costumes of men and women," how weapons were worn, and that men did not wear beards (Dreyer 1908, 516). Between the first excavation of a well-preserved coffin burial in 1823 and 1935, when the last oak-log coffin burial was discovered, archaeologists studied approximately 30 iron-pan encapsulated oak log coffins, with 20 sites providing dateable organic materials (Holst 2001).

But Dreyer and his contemporaries committed an egregious fault in their analysis that was only remedied in the end of the 20th century. Characteristic of many of these burials, whether or not the coffin survived thousands of years, was the formation of iron pans above and below the wet core. It was theorized that the formation of the iron pans was directly related to the high levels of preservation, but the prevailing assumption was that the iron pan formation was essentially accidental, and that the Bronze Age people who built the mounds could not have possibly predicted this outcome. As a direct product of the theory of cultural evolution, prehistoric Scandinavian communities were considered to be too primitive for the advanced foresight needed to plan such an intricate burial mound. From 1943 onwards, then, archaeologists viewed this phenomenon as "a mere nuisance in the interpretation of the excavation" (128). Little did they know, these iron pans were both intentional (most likely) and pivotal to understanding the preservation process.

With the discovery of some burial mounds containing iron pans in the 1990s, a team of researchers proposed that the iron pan formation was a product of redox processes in the soil, in which oxidized iron in the dry mantle was transported to the edge of the wet core. The anaerobic (lacking in oxygen) core then reduced the iron to a solid, immobile state. Over the years, this process resulted in iron pans encapsulating the core (Holst 2001; Breuning-Madsen 2001). When the team excavated their experimental mound, the soil composition analysis matched that of the real mounds, and the "coffin" remained intact. A study of a piece of pork that had been buried in the mound three years prior showed minimal decomposition—from a rancidity analysis, the pork could have been placed back in a grocery store and no one would have known the difference (Breuning-Madsen 2001, 696).

This new understanding of the mound-building process informed archaeologists that the mounds were built with precision and planning. In other words, the people who built these specific, well-preserved burials likely knew what they were doing—at least in terms of repeating the same building process for over a century. The burials needed to be built rapidly and in one event, otherwise the core would dry out before the mantle was built. Archaeologists also studied the distribution of these burials in South Scandinavia, and found that many were clustered in specific areas. With this knowledge, researchers explored the possibility of these particular mounds acting as communication devices between groups, possibly as markers for waterways and well-traveled roads (Holst 2001, 134). This new analysis and reinterpretation of the oak-log coffin burials from the 14th century BC revealed a wealth of information to archaeologists that proved the complex thought and foresight used by prehistoric Scandinavians.

With the research performed by Kristiansen *et al.*, radiocarbon dating burial sites with soil organic matter (SOM) was improved and can be considered a non-destructive option for archaeologists studying culturally-important sites. The team concluded that the soil fractions were suitable for dating, albeit less certain than a full excavation. The development is far from complete, but it serves as an example that the field is constantly improving on itself. That being said, as SOM fractionation continues to evolve, it may provide even more accurate dates for excavations: the decomposition of the SOM begins as soon as the sod is flipped and packed into a mound. In sites where grave objects are the primary dating source, SOM dating could help prove if the artifacts were contemporary to site.

From a purely chronological point of view, the developments in archaeology as an effect of scientific analysis is clear. Archaeologists and other specialists are able to extract valuable information about the multitude of cultures that existed in Scandinavia over the last six thousand years. That being said, while scientific analysis provides more data to be interpreted, the data cannot interpret itself. Archaeologists and anthropologists remain the experts in this situation, and theory is always in development. Niels Skak-Nielsen did not need scientific instruments to call for a reinterpretation of flint daggers found in Late Neolithic burials. In fact, extensive scientific analysis probably would not have revealed any useful information in this situation. For years, archaeologists assumed the flint daggers, which were the grave weapon of choice between the battle axes and the swords, were a weapon of war. Based on that context, the explanation makes sense. Skak-Nielsen, on the other hand, argues that a dagger is a ridiculously impractical weapon for war, and is generally associated with betrayal—the victim must trust the killer enough to let them get close enough to shove a short dagger into their body, after all. After analyzing the use-wear of the daggers and the location in relation to the interred body (usually worn on a belt), he proposes that the daggers were for ritual slaughtering and played a secondary social function as symbol of status (Skak-Nielsen 2009). This reinterpretation required no molecular or DNA analysis, just a greater degree of cultural context.

Archaeological theory, like most theory, is constantly changing and adapting to new information. At the time when cultural evolution was the prevalent theory in archaeology and anthropology, reliance on scientific methods was limited. As theories continue to develop and change, we find ourselves relying more scientific evidence to back up our claims, or even present new, unexpected avenues of interpretation. Rather than discussing a three-age system based on the mental capabilities of a primitive society, archaeologists today understand that all cultures are nuanced and evolve in different ways. We still use a three-age system, for example, but we also rely on radiocarbon dating and dendrochronology to correctly date objects. Archaeology and the natural sciences may be different, but archaeological theory and scientific analysis are not mutually exclusive.

How Have Developments in Studying Scandinavian Burials Changed Our Understanding of Viking Age Scandinavia?

You cannot escape the Vikings.

The meaning of this phrase has changed dramatically from the Viking Age to now: in the days of the Vikings, many people in the Northern Atlantic feared the raiders from Scandinavia. Today, the issue falls more along the lines of what television show you want to watch. Given the prevalence of "Vikings" in today's pop culture, appearing in operas, books, and television, it is interesting to know that much of what we know about Viking Age culture was derived from burials.

Viking Age Scandinavians were notoriously non-descriptive of their own lives. Aside from the Icelandic Sagas, the Book of Settlements (also Icelandic), and a strong supply of runestones, most written accounts of the daily lives of Scandinavians come from outside sources. That being said, even the Scandinavian sources seem questionable at times—the Icelandic Book of Settlements, for example, is suspected of listing a large number of imaginary settlers (Wicker 2012). Ibn Fadlan's account of a Viking burial in Bulgaria seems probable, but cannot be substantiated with archaeology because the site was, quite literally, burnt to the ground as a part of the funeral process. Much of what we know (or at least thought we knew) came from the accounts of monks in the Northern Atlantic: the Vikings were terrible raiders who pillaged the lands and killed everyone in their way. This, at least, was our understanding of those ambiguous raiders of the north for a long time.

So, what changed this stereotype? The answer is in archeology.

Throughout the 19th century, the world viewed the Vikings as "the Nordic archetypes of choice" who "laid the foundations of modern Scandinavia and were pioneers of northern Christianity" (Price 2014, 1). Throughout the 1920s and 1930s, Scandinavian archaeologists expanded their field of study with more single-site studies and large-scale projects, particularly focused in Greenland and Iceland (McGovern 1990). This idol-praise of the savage-yet-civilized pure Northern race became fodder for European fascism, and the fallout from World War II resulted in a severe lack in comparative and interpretative archaeology. During this recovery time, medieval archaeology was established as its own field of study in Europe—but Viking Age studies continued to languish. "The introduction of analytic methods and theoretical models borrowed from ecology, geography, and anthropology that so transformed prehistoric archaeology … only gradually penetrated medieval and Viking Age research," McGovern concludes (334). By the 1970s and 1980s, interpretation was still relatively static, but scholars began to introduce the idea of "a cosmopolitan population of traders, crafts-workers, travellers, and poets" rather than savage killers (Price 2014, 2).

"Renewed intensive fieldwork [in the North Atlantic] has been associated with theoretical and methodological innovation," McGovern writes, and then goes on to discuss the importance of ethnoarchaeological perspectives, climate impact investigations, and modern survey and excavation techniques (McGovern 1990: 335). Some of these "modern" techniques have already been discussed, such as radiocarbon dating with environmental corrections. James Barrett has worked with several other researchers to study Viking-Age burials in Orkney, Scotland (Barrett 2000; 2001; 2004). His work utilizes marine reservoir correction of radiocarbon dating to study these burials. Marine reservoir corrections, similar to atmospheric corrections discussed earlier, take into account dietary differences when dating human bones. Marine carbon is notoriously old compared to terrestrial carbon, so human cultures that rely heavily on marine foods in their diets tend to appear older than their terrestrial-meat-eating contemporaries (this difference in carbon isotopes present in skeletons can also help archaeologists understand diet and migration patterns). Marine reservoir corrections account for these problems and provide a more reliable calibration in these cases. Barret uses these corrections to analyze the cemeteries of Viking-Age communities in Orkney: by drawing from "fish bones and stable carbon isotopes," Barret is able to make conclusions about colonization, identity, gender, religion, and economy (2001; 2004).

Just as ancient Scandinavian cultures practiced a wide range of burial styles, Viking Age Scandinavians did so, too. While large burials for prominent community leaders were popular, archaeologists have also found boat burials, Norse-style and Christian-style burials, cremations and interments, mass graves and single graves, and even horse burials (Barrett 2000; Harris *et al.* 2017; Wicker 2012). In 1920, T. C. Lethbridge published a brief article in *Archaeological Journal* qualitatively describing a "large, grass-grown cairn" from the Viking Age, complete with a hand-drawn, not-to-scale sketch of the cairn itself (Lethbridge 1920, 135). Other than determining primary and secondary internments, the article does not go into any detail in terms of interpretation. Harris *et al.*, in their site study of a tenth-century Viking boat burial in Scotland, describe the rich burial as evoking "the mundane and the exotic, past and present, as well as local, national, and international identities" (Harris *et al.* 2017, 191). In addition to a descriptive analysis of the contents of the grave, the team also extrapolated information using micro-CT scans of teeth and then determining strontium, oxygen, lead, carbon, and nitrogen isotope profiles. Using those same isotope profiles, they determined the origins and lifestyle of the person interred.

Within the last fifty years, the North Atlantic has been a hotbed of archaeological activity, much of which has been focused on bioarcheology. In Greenland, for example, researchers have studied bioarcheological samples, paleoecological collections, and Norse settlements to better understand the presence of Norse settlers in Greenland (McGovern 1990). In England, a team of archaeologists have spent the last forty years studying the Viking mass grave located in Repton—a peculiarly inland location for a Viking army to be. Presented in a *NOVA* episode, the project leaders have witnessed the introduction of new techniques into the research and how these techniques have answered questions they had not realized existed (Gauvain 2009).

One of the most dramatic discoveries in the past fifty years of progression in Scandinavian archaeology was the DNA-confirmed existence of female warriors. Possibly as a product of the male-dominated field of archaeology until recently, it was always assumed that men were the Viking warriors while the women were left at home, completely defenseless. But not only could women be warriors, but they were substantially more involved in Scandinavian culture than Dreyer and his 20th-century contemporaries could have ever imagined (Alberge 2019; Gauvain 2009; Price 2014; Wicker 2012). From digital reconstructions to DNA analyses to boat reconstruction to metal detecting, the Viking Age is slowly but surely being revealed to us in full.

A History of Epic Proportions

In a similar fashion to ancient Scandinavian archaeology, Viking Age archaeology has only improved with time and technology. The field has essentially exploded in the past fifty years, and we know more about the many cultures of medieval Scandinavia than we had ever thought existed.

Greenland's population has always been accompanied by a large question mark. The cause of extinction of Norse settlers was long unknown, the interactions between Norse settlers and Thule Inuit heavily contested, and the sources of survival a true mystery. Since the 1970s, these questions have been partially answered. Relations with the Thule Inuit were likely a mix of friendly and hostile, and Norse Greenlanders largely relied on seals, caribou, and imported livestock for survival, for example (McGovern 2009, 342). A longstanding theory of Norse extinction on the island revolved around "inbreeding and 'racial degradation'" that resulted in "a female population with narrow pelvises unsuitable for successful childbirth" (344). The reader should be reminded at this time that much of archaeology in the past has been conducted by white men, and that this was published during fascist Europe.

Although the "incel-esque" theory of the female agenda to destroy humanity is tempting, it is completely wrong and scientifically unfounded. The "narrow pelvises" Hansen referred to were not a side effect of interracial relations, but a side effect of post-mortem decalcification and soil pressure on the skeletons (344). More recently, true scientific studies have utilized stable isotope archaeometry and dental morphology to study Norse diet, health, and nutrition.

Using and improving scientific methods in archaeology has had an undeniable and exemplary effect on our understanding of Viking Age Scandinavia. We now know that the Vikings were not a unified nation of savage killers: Scandinavia between 700 and 900 AD was composed of many smaller cultures living in close proximity. Neil Price summarizes the situation well in his introduction to the book *Viking Worlds*:

> A review of current perspectives on the early medieval Scandinavian worlds shows them to be numerous, pluralistic and in constant flux. Archaeologists share the field with historians, linguists, textual scholars, students of comparative religion, runologists, anthropologists, and specialists from the full spectrum of natural, physical, and biological sciences…The traditional views of the Viking Age are being expanded and nuanced with other, more cognitive readings" (Price 2014, 2).

Take the intersection of Norse religion and Christianity, for example. In Repton, England, the site of a mass grave of Scandinavian warriors is located in the church yard, suggesting brutal opposition between Christians and pagans. In Fregersley, Denmark, however, a bizarre burial mound led to an even more bizarre discovery (Puttock 2018). The burial mound, which was missing a body, contained exquisite pieces of gold jewelry designed not for humans, but for a horse. The bridle was dated to 950 AD, and X-ray technology determined the metal composition of the gold-gilded decorations. These metals, which could not be sourced in Denmark, directed researchers to the burial mound of King Gorm the Old—considered to be the first King of a united Denmark. After careful excavations of the grave, utilizing microexcavation techniques and X-ray technology, it was discovered that Gorm's body had been moved to a nearby church.

Gorm was not Christian.

At the end of the day, a metal alloy compositional analysis of a horse bridle and a runestone from 965 AD resulted in archaeologists pinpointing the time period when Denmark converted to Christianity. During the reign of King Herold, Denmark was under threat of the Holy Roman Empire. Most Scandinavians at this time were pagan, but some "converted" to Christianity in order to enter Christian communities to trade. To protect his people from attack, Herold declared the country to be Christian, although not many people actually believed in Christianity at the time. The following years resulted in moral turmoil—hence why many of the elite leaders of the past were moved from burial mounds to churches. This bizarre interaction of pagans and Christians is easily identifiable in grave sites: wherever Christians wore crosses, Vikings wore Thor's hammer—including at Repton.

In 2012, a bioarcheologist became the lead researcher for the ongoing excavations at Repton (Gauvain 2019). Researchers believe the mass grave in the churchyard was the lost army of King Olaf and his son Astine, based on the side-by-side graves of two elite men who had died in battle. DNA analysis revealed the two to be first-degree relatives, which would match with the fabled King Olaf. Combined with written records from the monks living in Repton, forensic analyses of the 270-odd people buried in the yard create a formidable story of war and desperation. Many radiocarbon dates from the bodies appeared to be a century older than the missing Viking Army, but once a maritime diet was accounted for (marine reservoir corrections), the dates matched up with the records. DNA analysis of the interred suggest that 20 percent of the mass grave was female, some of whom bear the scars of battle. This information, coupled with a site in nearby Formark, suggest that the army spent a significant amount of time in Repton.

As mentioned previously, the discovery of female warriors more or less brought the field to a screeching halt. It all began with a skeleton uncovered in 1889 in Birka, Sweden (Gauvain 2019). Although female warriors were referenced in medieval narratives, and despite eyewitness accounts of female warriors in the 970s, their role was often dismissed as folklore by historians and early archaeologists (Hedenstierna-Jonson *et al*. 2017; Price 2014). Because the person in Birka had been buried with a weapon, archaeologists had immediately assumed it was a man

(Gauvain 2019). Using the field drawings from the original excavation, though, archaeologists reconstructed the burial site—a rich burial, complete with a sword, a battle axe, and two horses. DNA confirmed the skeleton to be a woman in her thirties. This immediately called into question every assumption an archaeologist has made about the gender of a person based on grave goods.

Birka itself has been a sort of holy land for archaeologists. Located on a small island, the small occupation area has resulted in an impressive number of graves in a very small space (Wicker 2012). Birka has been excavated continuously since the 17th century; of the 1,016 excavated burials, 415 have been gender-assigned. Of those, 60 percent have been assigned female, and only 40 percent male. This gender ratio is unheard of in Scandinavian archaeology, and many have attempted to explain the general lack of female burials to female infanticide—a practice that was specifically outlawed by the Christian medieval law codes in Scandinavia. The practice was also referenced in family sagas, in terms of advocating for exposure, but now with more DNA analyses of skeletons available, it is possible that the sheer lack of female graves was the fault of archaeologists incorrectly relying on grave goods to assign biological sex. Regardless, the situation at Birka has allowed researchers to study female Scandinavians to a degree not previously considered. From this tiny island, archaeologists have been able to better understand the role of women in Viking age Scandinavian society.

Sweden was relatively late in converting to Christianity—the missionary Angsar arrived in Birka in the mid-ninth century, and successfully converted a few inhabitants, but the religion did not gain popularity until the eleventh century. Archaeologists have studied the relations between Christians and non-Christians via the burials left behind: interestingly, grave objects linked to Christianity have been almost exclusively associated with female graves. Archaeologists have interpreted this anomaly as owing to women playing the role as religious models for the community. Property-owning widows "chose to give their assets to charity," contributing to pious acts like road and bridge construction. Non-Christian women, who also wanted to demonstrate their power in the community, did so by constructing elaborate burials for themselves. With comparative analysis, archaeologists have extrapolated the conditions of burials into social relations between Christians and non-Christians in Birka, even down to the types of metal used for Thor's hammers and St. Peter's keys (Wicker 2012).

While the female warrior in Birka may have been the first excavated proof of women playing important roles in Scandinavian society, she has not been the last. A number of female graves with weapons as grave goods have been discovered (Price 2014). The DNA analysis of the "Viking Army" in Repton revealed that approximately 20 percent of those buried were women, and further forensic analysis revealed a number had probably died in battle (Gauvain 2019). The women in Birka proved, through their graves, that they could hold social positions and manage their own money (Wicker 2012). Even the presence of Scandinavian women in Repton implies the roles they played in Scandinavian communities, in that they would have travelled with their husbands to raids and settled in foreign lands. Compared to the last 200 years of male-focused Scandinavian archaeology, the last 25 years of studies, made possible through scientific analysis, have revolutionized female representation in the field.

Let us return to *Norsemen*, the Norwegian Viking show. With our improved understanding of Scandinavian culture, we can now ask: do the writers pay respect to the true Vikings, or it is full of stereotypes?

The answer is both. Of course, there are dramatizations—take the plotlines of the slaves, for example. From the eyes of Rufus, a new slave from Rome, all of the other slaves have been brainwashed into thinking the "savage" Vikings are pretty cool. When he tries to escape his sentence, Rufus ends up tied to a stake in a neighboring village, about to be sacrificed to Odin. But at the same time, the show depicts a number of characteristics we have only recently uncovered. The scene of the first episode opens on a fleet of warriors returning from the raids, ready to settle down and lead normal lives. The village is full of people going about their normal day, mostly as farmers. The country is hardly united as one "Viking" culture, which is evident when Olav is killed by an enemy chieftain just a few miles away. One of the best warriors is Frøya, a woman, who is treated like every other warrior. When Olav dies, his funeral includes some prized possessions, a sword, water, and fire—all elements found in Viking Age burials. The writers even manage to throw in a plot point with a map to the "West"—which could be Western Europe, but it could have also meant North America.

The show does a good job of incorporating accurate elements of Viking Age Scandinavia while maintaining a humorous disposition about the overly crass and ridiculous antics the characters endure. This culturally respectful interpretation, of course, would not exist if it were not for advancements in archaeological analysis of Viking Age burials.

In Conclusion

In the past fifty years, Viking Age archaeology has received an impressive makeover from its racist, androcentric origins. Thanks to developments in scientific techniques and instrumentations, we now understand the time period to be varied, nuanced, and diverse. We can reconstruct what people looked like based on DNA fragments and digital imaging. Researchers can trace the origins of specific individuals and study cultural change from the material analysis of a horse bridle. We also better understand the role women have played in history, as community leaders, as pioneers, and as warriors. These developments are not unique to Viking Age archaeology, though. It applies to Scandinavian burial archaeology as a whole, too:

chemical, geographic, and biological analyses have aided archaeologists in developing a better, more complete understanding of ancient Scandinavia.

Like many places in the world, Scandinavia and the Northern Atlantic have witnessed innumerable cultures rise and fall throughout humanity. Gleaning information about these cultures from what they left behind is difficult as best and impossible at worst. Thanks to interdisciplinary research, archaeologists and scientists can work in tandem to glean as much data as possible out of a cultural site. From there, archaeologists are able to support their theories or introduce new ones based on new information. Archaeology has come a long way from the 18^{th} century, and it undoubtedly will continue to evolve in the future.

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