



Resolving the Question of a Hiatus between the Paleolithic and Neolithic: Nineteenth-Century Science and a Problem in Human Prehistory

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RESEARCH NOTE

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ABSTRACT

In the 1870s a dispute arose between supporters and opponents of the idea that a hiatus existed between the Paleolithic and the Neolithic, a period when Europe was uninhabited. Researchers invoked geological, paleontological, archaeological, and anthropological evidence to support their views. This paper discusses the development of this debate and how it was resolved, in large part due to the excavations of Édouard Piette.

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KEYWORDS:

Mesolithic; Paleolithic; prehistoric archaeology; Édouard Piette; Mas d'Azil; Gabriel de Mortillet; Émile Cartailhac

TO CITE THIS ARTICLE:

Goodrum, MR. 2021. Resolving the Question of a Hiatus between the Paleolithic and Neolithic: Nineteenth-Century Science and a Problem in Human Prehistory. *Bulletin of the History of Archaeology*, 31(1): 1, pp. 1–12. DOI: <https://doi.org/10.5334/bha-657>

During the second half of the nineteenth century, the recognition that human prehistory extended back into the Pleistocene generated new questions and problems that needed to be answered. A protracted debate over the apparent discovery of stone artifacts among extinct Pleistocene animal fossils eventually led to the acceptance of the 'geological antiquity of man.' The idea that humans coexisted with mammoths during the Ice Age was astounding to many and remained controversial for years. Historians have traced these events (Grayson 1983; Cohen and Hublin 1989; Van Riper 1993), but once this debate was resolved a host of new questions arose. Geologists and archaeologists throughout Europe turned their attention to investigating this earliest phase of human prehistory. Many noted that the crudely chipped stone tools found in Pleistocene deposits differed greatly from the finely polished tools found in much later prehistoric burials. By the 1860s, French prehistorians began distinguishing between an 'âge de la pierre taillée' and an 'âge de la pierre polie' while the English prehistorian John Lubbock invented the terms Paleolithic and Neolithic to distinguish these two types of tools belonging to two very different periods of time.

With this framework in place, researchers turned their attention to a range of problems relating to the stratigraphy of Pleistocene deposits, the changes in its fossil fauna over time, and establishing a classification and a relative chronology of Paleolithic artifacts (see O'Connor 2007; McNabb 2012; Chazan 1995). One of the most influential achievements of this effort was French archaeologist Gabriel de Mortillet's division of the Paleolithic into a sequence of periods identified by distinct tool types. He modified this scheme several times but in his classic work *Le préhistorique* (1883) Mortillet divided the Paleolithic into the Chellean, Mousterian, Solutrean, and Magdalenian periods. Historians of archaeology have written extensively about Mortillet's periodization of the Paleolithic, his commitment to the idea of a linear progressive conception of cultural evolution, and his materialistic views of human origins (Richard 2008; Pautrat 1993). The surge of research into the Paleolithic that began in the 1860s produced great quantities of stone tools, art objects, and even human skeletons but inevitably disputes arose over the interpretation of the evidence collected.

During the 1870s questions arose over the transition from the Paleolithic to the Neolithic in Europe. There were important issues at stake. One group thought the Paleolithic population of Europe disappeared at the end of the Pleistocene, along with much of the Ice Age fauna, and that a new population migrated into Europe some time later ushering in the Neolithic. In their view there was a 'hiatus,' a gap between the Paleolithic and the Neolithic. This was a chronological gap, but also an archaeological and anthropological gap separating two very different peoples with very different cultures. On the other hand, there were others who argued for continuity between the Paleolithic and the Neolithic in Europe. They believed the Paleolithic population had not disappeared at the end of the Ice Age and that there was a transition from the Paleolithic to the Neolithic without a hiatus.

This paper examines the arguments proposed by the supporters of these two scenarios. It offers another illustration of how geological, paleontological, archaeological, and anthropological evidence were all crucial elements in the arguments constructed by both sides. This is consistent with what historians have shown with respect to other episodes in the development of Paleolithic archaeology in the nineteenth century. This dispute over the presumed hiatus was largely resolved by the end of the 1880s, in large part due to the excavations of Édouard Piette, although other evidence was important as well. I will focus on Piette's discoveries and ideas because the participants in this debate saw Piette's work as important to resolving the questions at hand and because Piette presented the results of his research as solving the problem of the transition from the Paleolithic to the Neolithic in Europe.

Examining the history of these events does not simply add to our understanding of the history of Paleolithic archaeology. It offers an opportunity to scrutinize how some scientific disagreements get resolved. It also contributes to scholarship on periodization in Paleolithic archaeology (see Guillomet-Malpassari 2005; Bon 2018; Moro Abadía 2002; 2005). This paper also contributes to the history of the emergence of the idea of a distinct Mesolithic period. Several historians and archaeologists have written about the origins and early debates over the idea of the Mesolithic (Rowley-Conwy 1996; Rozoy 1995; Czarnik 1976; Binford 1968). It is essential to be clear that the present paper avoids the Whig history approach that would

see the events described below as ‘leading toward’ the idea of a Mesolithic. These researchers were not working toward the idea of a Mesolithic period, they were arguing over a narrow set of questions around the existence of a hiatus between the Paleolithic and the Neolithic. The nature of that discussion and how it was resolved is the focus of this paper. The fact that these events then contributed to a debate over a new problem, defining and validating a distinct Mesolithic period, is the worthy subject of a separate paper.

MAKING THE CASE FOR AND AGAINST A HIATUS

Many archaeologists attributed the origin of the idea of a hiatus between the Paleolithic and the Neolithic to the French geologist Édouard Lartet (1801–71). Lartet was one of the first French scientists to accept the archaeological evidence that humans had lived during the Pleistocene and throughout the 1860s he excavated Paleolithic sites in the Dordogne region of France. While he was helping to arrange the prehistoric exhibit for the 1867 *Exposition Universelle* in Paris, Lartet apparently commented on the discontinuity between the artifacts of these periods and that an intermediate period linking them had not yet been found (Piette 1995: 235–236). However, François-Alphonse Forel (1841–1912) was among the first to formulate a systematic argument in favor of a hiatus. Forel was professor of anatomy at the Académie in Lausanne, Switzerland, but he had also studied Swiss prehistoric sites. Forel argued that a gap separated the Neolithic from the Reindeer Age, a term widely used in the 1870s to refer to the last portion of the glacial period. He based this conclusion on geological and archaeological evidence. He observed that the glacial fauna disappeared in Switzerland at the end of the Pleistocene and was replaced by animals almost identical to modern fauna. This seemed to correspond in the archaeological record with the disappearance of the reindeer hunters who made Paleolithic flint tools. Forel argued that these people were eventually replaced by Neolithic farmers who possessed polished stone tools and pottery. There was yet another cultural difference between these two peoples. The finely carved sculptures of extinct animals made during the Reindeer Age also disappear at the end of the Paleolithic and only abstract geometrical forms of decoration are found in Neolithic sites. As Forel (1870: 576–577) saw it, the Neolithic was a completely new world from what had preceded it. Forel noted that there existed a continuous record linking the Neolithic to the Bronze and Iron Ages and thus into Roman times. But on the contrary, there was a notable gap of unknown length separating the end of the Reindeer Age from the first Neolithic lake-dwellings in Switzerland. He is careful to acknowledge that he does not know how much time separates these two periods, but it could not be small. ‘I want to try to make it clear that the gap between the Reindeer Age and the age of polished stone is considerable, but not very great,’ wrote Forel. He thought in terms of thousands of years, but not millions (Forel 1870: 578–579, 589). While Forel was one of the first to set forth evidence for a hiatus between the Paleolithic and the Neolithic, the most influential proponents of this idea were Émile Cartailhac and Gabriel de Mortillet.

In January 1870, the prehistoric archaeologist Émile Cartailhac (1845–1921) read a paper before the *Société archéologique du Midi de la France* making the case for a hiatus. Like Forel, he relied on both paleontological and archaeological evidence, but much of his argument was new. He enumerated the many animal species that inhabited France at the end of the Pleistocene, especially the reindeer whose abundance gave the Reindeer Age its name. Yet almost all of these animals either became extinct at the end of the glacial period or migrated far to the north and were replaced by a new fauna in the Neolithic. Regarding the archaeological record, Cartailhac not only points to the difference between the crudely chipped Paleolithic artifacts and the finely polished Neolithic tools, but he also argued that there was no evidence for a continuous development of the former into the latter in Europe. Importantly, pottery is absent from Paleolithic deposits, but common in Neolithic sites. Further evidence of a complete difference in culture is the fact that the people of the Reindeer Age lived by hunting, while the Neolithic population practiced agriculture and had domesticated animals (Cartailhac 1872: 327–328).

Cartailhac employed some of the discoveries made by the Belgian geologist Édouard Dupont (1841–1911), who had excavated caves in Belgium in the late 1860s, to support this argument. Dupont found stratigraphic evidence for a sharp break separating Paleolithic deposits from Neolithic ones in caves, which Dupont interpreted as evidence that the Belgian caves ceased to be inhabited around the beginning of the Neolithic. Cartailhac also pointed to Dupont’s discovery that the flint used to manufacture Neolithic tools came from the region of Hainaut, while the

flint used for Paleolithic tools came from Champagne, which indicated these were two distinct peoples. Cartailhac rejected the suggestion that these differences could be explained by positing one population of cave dwellers who lived in the mountains alongside a separate population living in the valleys. Rather, in order to explain the origin of the Neolithic in Europe, Cartailhac argued that during the end of the Paleolithic there must have been peoples living in some other part of the world who gradually developed polished stone tools, pottery, and agriculture. A transition had taken place from the Paleolithic to the Neolithic, but it had not happened in Europe and it was the task of archaeologists to discover where it had happened (Cartailhac 1872: 328–331).

Gabriel de Mortillet (1821–89) was also convinced of a hiatus separating the Paleolithic from the Neolithic. Mortillet was appointed curator of the *Musée des antiquités celtiques et gallo-romaines* in 1868 and became professor of prehistoric anthropology at the *École d'anthropologie* in 1876. His expertise in prehistoric archaeology led him to propose a sequence of chronological periods during the Paleolithic that was initially controversial but eventually became widely adopted. It was in a paper outlining his subdivision of the Paleolithic presented at the *Congrès International d'Anthropologie et d'Archéologie Préhistorique*, held in Brussels in 1872, that Mortillet expressed his views about a hiatus. Mortillet proposed a 'regular and logical development' of stone artifacts during the Paleolithic and that these artifacts could be chronologically arranged into Acheulean, Mousterian, Solutrean, and Magdalenian periods.¹ His Magdalenian period corresponded with the Reindeer Age mentioned by many French prehistorians. While there were clear transitions linking the artifacts from a prior period to the one that followed it, Mortillet (1872: 440–453) perceived a discontinuity, 'a wide and deep gap' separating the Magdalenian from the Neolithic. There was a complete transformation between these two types of tools. The differences between these two periods was also made clear by the fossil record, since the Magdalenian fauna differed markedly from the Neolithic fauna. Furthermore, the culture of the new Neolithic inhabitants of Europe was completely different from their Magdalenian predecessors. Not only did they possess polished stone tools and pottery, domesticated animals and agriculture, but they also erected dolmens and other megalithic monuments. In his opinion, these facts indicated 'a complete change' (un changement complet) from what had gone before. In the discussion that followed his presentation, Mortillet also pointed to the abundance of Magdalenian animal sculptures and engravings, which are absent in the Neolithic. Cartailhac agreed with Mortillet and stated that in the south-west of France the 'chasm' (abîme) separating the Paleolithic from the Neolithic was clearly marked. Not only caves but perhaps the country as a whole seemed to have been uninhabited for a time. For Cartailhac, regarding the Neolithic inhabitants of Europe, 'there is no analogy, no point of contact, between them and their predecessors of the Reindeer Age' (Mortillet 1872: 453).

There were others, however, who did not accept the idea of a hiatus. The French anthropologist Paul Broca (1824–80) was present at Mortillet's talk and he disagreed with his depiction of a 'sudden and profound hiatus' (un hiatus subit et profond) between the Paleolithic and the Neolithic. Broca (1872: 182–183) characterized this hypothesis in these rather disparaging terms: 'At a certain moment the chain of time seems suddenly broken, and when our hand can seize it again, the old order of things has entirely disappeared; in its place, we find a new order of things, without any transition establishing a passage from one to the other.' In a paper also presented at the Brussels Congress, Broca expressed his skepticism regarding some of the evidence advanced in support of this hiatus. More importantly, he believed he had evidence of the transition from the Paleolithic to the Neolithic. This evidence came from the Caverne de l'Homme Mort, a cave located in the department of Lozère in southern France. The physician and amateur archaeologist Barthélémy Prunières (1828–93) had excavated the cave, first in 1870 and more thoroughly in 1872. Prunières unearthed flint tools and fragments of pottery, but even more remarkably he recovered human bones from approximately fifty individuals, including twenty undamaged skulls (Prunières 1873). Prunières sent the bones to the *Société d'Anthropologie de Paris* for Broca to examine. By this time Broca had established a reputation for his studies of prehistoric human skeletons, including the Cro-Magnon fossils discovered in 1868 (Goodrum 2014).

After examining the skeletons and artifacts from the Caverne de l'Homme Mort, Broca (1872: 185–195) concluded that this site helped to establish the transition between the Paleolithic and

¹ Mortillet altered his scheme for subdividing the Paleolithic throughout his career. His first scheme was proposed in 1869, but he modified this in 1872. The final version (Mortillet 1883) consisted of Chellean, Mousterian, Solutrean, and Magdalenian periods.

Neolithic. He drew attention to the fossil fauna of the Paleolithic and its distinctive flint artifacts and lack of pottery, but he also pointed to the fact that the humans of the Paleolithic lived in caves and even buried their dead in caves. He cited as evidence of this last point the excavations conducted by Édouard Lartet at Aurignac, where human skeletons had been discovered. In contrast, the Neolithic was characterized not only by domesticated animals, polished stone tools, and pottery but also by the fact that the people of this period no longer lived in caves and they buried their dead in megalithic tombs. In the Caverne de l'Homme Mort there were elements from both periods. The animal bones all belonged to a post-Pleistocene fauna, and pottery and a polished flint artifact were present. But on the other hand, domesticated animals were absent and these people had lived in and had buried their dead in the cave, as at Aurignac. Here were modern animals and Neolithic artifacts among a people who still engaged in the Paleolithic practice of burying their dead in sepulchral caves. To this Broca added the anthropological evidence from the skeletons. When Broca measured the skulls from the Caverne de l'Homme Mort he found they were very dolichocephalic (oval shaped), like the Paleolithic Cro-Magnon people. But Prunières had also collected skeletons from Neolithic and Bronze Age tombs in the same region of Lozère and Broca observed that those skulls were brachycephalic (round shaped), indicating that these later people belonged to a completely different race.

To explain this peculiar combination of faunal, archaeological, and anthropological facts, Broca suggested that the dolichocephalic population that inhabited Europe during the Paleolithic did not simply disappear at the end of the Pleistocene. When the brachycephalic Neolithic newcomers arrived in Europe they may have conquered these Paleolithic peoples, but the latter did not immediately disappear. It appeared that the local Paleolithic people persisted for a long time in certain places and while maintaining their former way of living, had also adopted the polished stone tools of the newcomers. While Broca believed that these last remaining pockets of Paleolithic people eventually died out, he thought it was extremely likely that the skeletons from the Caverne de l'Homme Mort belonged to one of these Paleolithic populations that survived into the Neolithic period and that they coexisted alongside the Neolithic newcomers for some time. During the discussion that followed Broca's presentation, Paul Cazalis de Fondouce (1835–1931) expressed his support for Broca's conclusions and cited in turn his excavation of the sepulchral cave of Saint Jean d'Alcas in 1867, where he had also found artifacts of the exact same type as artifacts recovered from nearby Neolithic tombs. This appeared to be another example of a Neolithic people who had descended from earlier Paleolithic populations and retained the practice of burying their dead in caves. Cazalis de Fondouce eagerly agreed with Broca that the hiatus identified by Cartailhac and Mortillet did not exist (Broca 1872: 196–199).

From here the disagreement over a hiatus separating the Paleolithic and the Neolithic gathered pace. Many of the participants who had discussed this hiatus at the Brussels Congress of 1872 assembled again for the meeting of the *Association Française pour l'Avancement des Sciences* held in Lyon in August 1873. The subject arose once more and the most original new argument to emerge came from Clémence Royer (1830–1902). Royer was the first female member of the *Société d'Anthropologie de Paris* and she produced the first French translation of Darwin's *On the Origin of Species* in 1862. Royer pointed to geological evidence that the plains of western Europe had been uninhabitable during the period between the end of the Reindeer Age and the Neolithic due to the widespread flooding of rivers that occurred at the end of the Pleistocene caused by the melting of the glaciers. She argued that these floods had forced the people of the Reindeer Age to migrate out of France and that only when the water had receded did new Neolithic people migrate into France. However, following Broca, she thought that some surviving populations of the Reindeer Age persisted in France, living in caves in high mountains and other places protected from the flooding, and that these Paleolithic people eventually came into conflict with the Neolithic immigrants and were eventually absorbed into this Neolithic population (Anon. 1874: 680–681).

As the discussion over a hiatus continued the most adamant critic of the idea was Paul Cazalis de Fondouce. He was a civil engineer but his interest in geology and prehistory led him to excavate several prehistoric sites. He was a member of the *Société archéologique de Montpellier* and by this time had experience investigating Paleolithic cave deposits. At the *Congrès International d'Anthropologie et d'Archéologie Préhistorique* held in Stockholm in 1874, Cazalis de Fondouce read a paper that systematically critiqued each of the primary components of the hiatus hypothesis (he used the term lacuna instead of hiatus). This paper drew added attention by being reprinted, under a new title, in the journal *Revue d'Anthropologie*.

Regarding the claim for geological evidence of a layer of alluvium or stalagmite at many sites situated stratigraphically between deposits from the Reindeer Age (Magdalenian) and those from the Neolithic, Cazalis de Fondouce (1874a: 116–119) responded that while some sites may possess such a layer, this may simply suggest periods when those sites were uninhabited. However, he noted that there were caves in the Pyrenees where the Neolithic strata were not separated from earlier layers by a stalagmite layer. For instance, in the deposits at Bize, Neolithic hearths containing pottery lay immediately over strata from the Reindeer Age. He also mentioned the recent excavations of Édouard Piette at the Grotte de Gourdan where there was equally no break in the stratigraphy between these periods.

As for the paleontological evidence that much of the Pleistocene fauna suddenly became extinct at the end of the glacial period and was then replaced by a modern European fauna, he rejected the idea of such a rapid and complete replacement. He thought that Pleistocene animals disappeared gradually, not all at once. He cited as evidence the survival of the auroch, elk, brown bear, and other late Pleistocene animals into post-glacial times. The implication here was that if some late Pleistocene animals had survived then it was possible that humans had also survived the transition from glacial to post-glacial Europe. Supporters of a hiatus also made much of the Neolithic introduction of domesticated animals. Cazalis de Fondouce agreed that this did indicate the arrival of a new population into Europe that possessed a new culture, but he wondered if some steps toward the domestication of the dog, horse, and reindeer had not already begun at the end of the Paleolithic (Cazalis de Fondouce 1874a: 119–124).

He then confronted the archaeological evidence for a discontinuity between the artifacts of the Paleolithic and the Neolithic and addressed Gabriel de Mortillet's linear sequence of artifact types that underlay his subdivision of the Paleolithic and of a hiatus. Cazalis de Fondouce critiqued the archaeological arguments presented by Cartailhac and Mortillet for a hiatus and he cited evidence indicating there had been a continuous evolution of Paleolithic artifacts into Neolithic ones. And while he agreed that pottery only appeared in the Neolithic, he thought it significant that clay was used to make ornaments during the Magdalenian period. There also appeared to be continuity in the use of harpoons from the Magdalenian to the Neolithic. Lastly, Cazalis de Fondouce expressed doubt over the anthropological claim that the Paleolithic people of Europe became extinct at the end of the Pleistocene and were replaced by distinct Neolithic peoples (Cazalis de Fondouce 1874a: 114–116, 124–131).

Cazalis de Fondouce concluded that, contrary to those who defended the idea of a hiatus or lacuna separating the Paleolithic and Neolithic, the evidence instead indicated that the changes linking these periods were slow and there was an uninterrupted continuity from the end of the Paleolithic to the beginning of the Neolithic. As support for this idea he referred his listeners to the recent excavations conducted by Louis Lartet (1840–99) and Gatien Champlain-Duparc at the Grotte de Duruthy, where they unearthed a sequence of stratigraphic layers linking the Paleolithic with the Neolithic. The scenario that Cazalis de Fondouce proposed instead was an image of prehistoric France where new 'races' of people were continually arriving from other regions, due to changes in climate, and these newcomers coexisted with those populations already present. One of those new groups introduced the arts and industries of the Neolithic period, with the result that some of the older Paleolithic peoples were absorbed into the Neolithic population without being totally exterminated (Cazalis de Fondouce 1874a: 132).

The force of this critique prompted Émile Cartailhac to immediately respond in a paper published in *Matériaux pour l'histoire positive et philosophique de l'homme* (Cartailhac 1874). In his opinion, prehistorians had to accept the reality of a 'lacuna' between the Paleolithic and the Neolithic. But perhaps in recognition that the evidence for a hiatus was not as strong as he previously thought, Cartailhac contended that if researchers could not accept the validity of this hiatus, then it would be necessary to postpone the solution of the problem until more excavations were made. In defense of the idea of a hiatus, however, he pointed once again to the evidence that the culture of the Neolithic must belong to a new population arriving in Europe, since it surely took a long time for all their technological and cultural innovations to be invented. He concluded by saying that only new anthropological and archaeological evidence would resolve the question of the origin of Neolithic people. Importantly, there was one person that Cartailhac mentioned whose recent research was beginning to shine new light on the transition from the Paleolithic and the Neolithic, and that was Édouard Piette.

PIETTE AND THE EVIDENCE FOR A TRANSITIONAL PERIOD

Édouard Piette became involved in Paleolithic archaeology after visiting the spa town of Bagnères-de-Luchon, located at the foot of the Pyrenees in the southwest of France, in 1871. He had gone there to recover from the stress of the Franco-Prussian War and while there he encountered Édouard Lartet, who encouraged Piette to explore the caves in the region. Piette had obtained a law degree in 1852, but his interest in geology led him to attend lectures at the *Muséum National d'Histoire Naturelle* and at the *École des Mines* in Paris. Piette held several legal positions in various towns until being appointed a judge in 1882. However, he never lost his interest in geology and during the 1860s and 1870s he published works on the geology and paleontology of several regions in France (Fischer 1906; Goodrum 2019). But after his visit to Bagnères-de-Luchon Piette's research turned to investigating the Paleolithic caves in the Pyrenees.



Figure 1 Édouard Piette.

Piette began excavating the Grotte de Gourdan in 1871 and he soon unearthed a sequence of strata containing artifacts, hearths, and animal fossils ranging from the Reindeer Age to the Neolithic. In April 1873 Piette presented a paper to the *Société d'Anthropologie de Paris* summarizing his remarkable discoveries. He observed that in some portions of the cave, a stalagmite layer as much as 30cm thick separated the strata of the Reindeer Age from the Neolithic deposits lying above. But in other parts of the cave the Neolithic deposits lay

immediately above the deposits from the Reindeer Age, without any signs of a geological disturbance between them. It seemed that the Neolithic newcomers to the cave had arrived right after the Magdalenian inhabitants had left. Piette noted that there were other sites, such as Bize and Laugerie-Basse, where Neolithic deposits lay immediately above strata belonging to the Reindeer Age (Piette 1873: 387–390).

Piette recognized that these discoveries contradicted the hypothesis proposed by Forel just a few years earlier that parts of Europe had been uninhabited for some time at the end of the Reindeer Age. Piette responded to Forel by drawing upon his own wide experience with the Pleistocene geology of France, asserting that there was no evidence that France had been submerged under water at the end of the Pleistocene. Having dismissed the geological argument for a hiatus, Piette addressed the archaeological evidence. It was true, he said, that Magdalenian artifacts differed greatly from Neolithic ones. Yet he offered an explanation for this that did not rely on a hiatus or the arrival of a new people. Piette's investigation of the geological deposits in the Pyrenees showed that the glaciers retreated over a 'long series of centuries' (*une longue série de siècles*), not abruptly as some supposed. The changes in the environment gradually led to the disappearance of the reindeer, which was a disaster for the reindeer hunters of the Magdalenian. Not only did they rely on reindeer for food, but many of their tools were made from reindeer antler and bone. With the disappearance of the reindeer the Magdalenian period came to an end, but that did not mean that the Magdalenian people disappeared too (Piette 1873: 392–396).

Piette suggested this scenario instead. While the Magdalenian peoples of France were developing their culture during the Reindeer Age, other peoples inhabiting regions where reindeer were absent may have developed a different culture consisting of domesticated animals and polished stone tools. Piette imagined that these latter people were probably in contact with some Magdalenian peoples during the time the reindeer began to disappear. With the loss of the reindeer, the Magdalenian population may have dramatically decreased, but they did not become extinct. Rather, according to Piette, the survivors probably began to adopt the polished stone tools and the domestication of animals they had observed among their neighbors. Thus, for Piette, the replacement of Magdalenian artifacts with Neolithic ones was not the result of the arrival of a new group of people into Europe. Rather, the disappearance of the reindeer forced the local Magdalenian people to abandon making tools from reindeer antler, so they used stone instead. There was no reason to make Europe 'a vast desert for thousands of years' as some were suggesting. Rather than a hiatus, there was continuity between the Magdalenian period and the Neolithic, which was consistent with what he had found in the stratigraphy in the Gourdan cave (Piette 1873: 396–401).

While work at Gourdan continued, Piette began excavating another cave, called Grotte de Lortet, in 1873. It too contained a series of deposits dating from the Reindeer Age and by comparing the two sites Piette hoped to work out a detailed archaeological record of this period. When Piette outlined his latest discoveries from Lortet at a meeting of the *Société d'Anthropologie de Paris* in 1874, Félix Garrigou (1835–1920) challenged his claims for continuity between the Reindeer Age and the Neolithic. Garrigou had extensive experience excavating Paleolithic sites, often with his colleague Henri Filhol (1843–1902). Garrigou stated that having explored seventy-five caves, he could not agree with Piette. There certainly were caves where Neolithic deposits lay immediately above those from the Reindeer Age, but there were also caves where Neolithic deposits lay immediately above even more ancient strata, but that did not mean the former followed immediately after the latter. Garrigou noted that at the Grotte de la Vache, which he had excavated in 1866, a stalagmite layer one meter thick separated the Neolithic from the Reindeer Age layers (see Garrigou 1867). In addition to this geological evidence for a hiatus, Garrigou pointed to the complete change in customs, tools, and 'intellectual manifestations' between the Magdalenian and the Neolithic as a sure sign that they were completely different peoples. Garrigou rejected Piette's argument for a continuous transition from the one period to the other and asserted instead that the evidence indicated a hiatus (Piette 1874: 306–307). The most remarkable remark made in response to Piette's paper came from Gabriel de Mortillet. He stated that the hiatus separating the Magdalenian and the Neolithic did not represent a true temporal gap, but rather was simply a 'gap in our knowledge' (*lacune dans nos connaissances*). Apparently clarifying the argument he had made in Brussels two years earlier for a hiatus, Mortillet argued that the Paleolithic certainly developed into the Neolithic, but transition deposits had not been discovered yet. He now stated that there had been no period when

Europe was uninhabitable during prehistory and that he had previously promoted the idea of a hiatus in order to stimulate research into the problem (Piette 1874: 317).

As discussion and disagreement over the existence of a hiatus continued, Piette undertook new excavations that dramatically shifted the debate for many of those involved. Near the village of Mas d'Azil, in the foothills of the Pyrenees in Ariège, the Arize River flows through an enormous tunnel in the rock. Repair to the nearby road had unearthed geological deposits in the tunnel and these attracted Piette's attention. From 1887 through 1888 Piette excavated the deposits at Mas d'Azil, where he uncovered a series of archaeological deposits representing what he referred to as a previously unknown transition period (*époque de transition*) lying between glacial times and geologically modern times. He pointedly added that some archaeologists had suspected that this transition period existed but evidence for it had remained largely unknown until now (Piette 1891: 203; Piette 1889: 422–423). Piette announced his discoveries in 1889, delivering a brief paper to the *Académie des Sciences* and a longer account read at the *Congrès International d'Anthropologie et d'Archéologie Préhistorique* in August of the same year. Piette presented a full description of his discoveries and his interpretation of them at the meeting of the *Association Française pour l'Avancement des Sciences* in September 1892.

Understanding the stratigraphy of the site and its artifacts was critical and in each successive paper Piette provided an increasingly detailed record of these essential facts. The deepest, and thus the oldest, deposits at Mas d'Azil contained Magdalenian artifacts made from reindeer antler and flint, including harpoons, and the most common animal bones were of reindeer and other species of deer. Above these were layers containing new types of harpoons made from reindeer antler as well as tools made from red deer antler. These deposits contained bones from the red deer (*Cervus elaphus*), chamois, horse, and wild boar. Among these Magdalenian artifacts, Piette also recovered distinctive scrapers and knives made from flint that he referred to as 'precursors of new times' (*précurseurs des temps nouveaux*). He also noted that these layers had been reworked by water. Piette believed this layer marked the end of the Magdalenian. Significantly, above this layer was a thin deposit of silt and above this were layers containing hearths, flint artifacts, harpoons made from red deer antler, barbed arrowheads, and painted pebbles. The animal bones in these layers included red deer and horse, but reindeer bones were absent. The layers above these contained polished stone axes, pieces of pottery, and other artifacts belonging to the Neolithic. Notably, the animal bones belonged to deer, pig, goat, and sheep. Finally, the uppermost layers contained Gallic pottery from the Iron Age (Piette 1892: 651–653; see also Piette 1889: 422–423 and Piette 1895: 240–248). Piette took particular note of the thin silt deposits lying above the uppermost deposits of the Reindeer Age (Magdalenian). They were evidence of a series of floods during the final portion of the Reindeer Age, caused by torrential rains and melting glaciers, and thus these deposits shed light, in Piette's opinion, on the climate at the end of the Pleistocene (Piette 1892: 653).

Using this archaeological and paleontological evidence in combination with the stratigraphy at Mas d'Azil, Piette attempted to reconstruct the sequence of events recorded there. Its geological deposits preserved a long chronology that began with the late Magdalenian. Reindeer were still present in the Pyrenees, but many of the animal bones belonged to a modern fauna. The climate was warming, however, and reindeer were gradually disappearing. As reindeer became scarce the Magdalenian people who relied on reindeer antler and bone to make so many of their tools, as well as for sculpting and engraving animal figures, were forced to adapt. Piette noted that while harpoons from the lower deposits at Mas d'Azil were made from reindeer antler, after the reindeer disappeared these harpoons continued to be made, but they now had a different form and were made from red deer antler. The distinctive new types of flint artifacts that he referred to as 'precursors of new times,' which were present in the uppermost Magdalenian deposits, persisted into the later deposits of this new transition period (Piette 1895: 249–251; Piette 1889: 422–424).

For Piette, the thin silt layers represented the end of the Pleistocene, when rain and melting glaciers produced floods in the Pyrenees. However, he stressed that these floods were periodic and temporary, and thus they did not represent a hiatus. Moreover, the continuity in artifacts, harpoons and flint tools, from the earlier Magdalenian deposits through these transitional deposits, indicated the continuity of the population as these Magdalenian people adjusted the best they could to a new climate and the loss of the reindeer. Finally, Piette suggests that once the glaciers had retreated these Magdalenian people then came in contact with Neolithic peoples who were now able to migrate into France. They introduced polished stone tools,

pottery, agriculture and domesticated animals. He proposed that the surviving Magdalenian inhabitants of the region gradually adopted the culture and technology of the Neolithic newcomers. As a consequence, their culture was transformed and they were eventually absorbed into the Neolithic population of France (Piette 1895: 249–251; Piette 1889: 422–424).

Piette's initial announcement of the discoveries at Mas d'Azil, which contained far less detail than his later papers, were received with some skepticism so he invited the members of a commission established by the *Société d'Histoire Naturelle de Toulouse* to inspect the site for themselves. Unfortunately, they arrived on a day when Piette could not be present because of his official duties, which only aggravated the situation. Piette responded by inviting some of the leading experts on prehistory in Paris to examine the site, but few were willing to undertake the long and expensive journey to Mas d'Azil. However, the renowned paleontologist Albert Gaudry (1827–1908) was convinced of the importance of Piette's discoveries so he directed Marcellin Boule (1861–1942), a young paleontologist with an interest in the Paleolithic and currently serving as secretary of the *Société Géologique de France*, to inspect the site (Piette 1895: 259–260).

During the discussion that followed Piette's presentation at the *Congrès International d'Anthropologie et d'Archéologie Préhistorique* in August 1889, Boule described his visit to Mas d'Azil and he verified Piette's description of the site and its artifacts. Boule also noted the similarity between the artifacts Piette found in the transition layers there and artifacts that he and Cartailhac had recently unearthed in the upper layers of a cave called Grotte de Reilhac. They found an uninterrupted sequence of strata in this cave that spanned the end of the Pleistocene to the beginning of post-Pleistocene times. In their publication on this site, Cartailhac and Boule (1889) concluded that the gap separating the Paleolithic from the Neolithic was of short duration at this site. Those discoveries combined with his own observations of the strata at Mas d'Azil now prompted Boule to affirm that Piette's research had resolved the question of a hiatus (Piette 1891: 209–210).

Cartailhac's response to Piette's presentation is particularly telling. He stated that it had been several years since he had insisted on the importance of a hiatus between the Paleolithic and the Neolithic. Indeed, he noted that since 1878 he had argued for the necessity of a long transition from the end of the Paleolithic to the beginning of the Neolithic, since the domestication of animals, the invention of agriculture, and the advent of pottery making would all take a long time to occur. So, while open to accepting Piette's evidence for a transition period at Mas d'Azil, Cartailhac cautioned that it was difficult to generalize Piette's discoveries to other areas of Europe and he for one remained unsure that the question of the hiatus was fully resolved (Piette 1891: 212–213). Meanwhile, Piette continued to make his case. At the International Exposition held in Paris in 1889, Piette assembled an exhibition of the artifacts he had collected from Gourdan, Mas d'Azil and other sites. He arranged them chronologically in order to show how they had changed from the Magdalenian to the Neolithic (Piette 1895: 254). Then in 1890, Cartailhac traveled to Mas d'Azil to inspect the stratigraphy and the artifacts firsthand. Like Boule, he came away convinced of the veracity of Piette's discoveries and he now accepted the evidence for a transitional period between the Paleolithic and the Neolithic (Cartailhac 1891; Piette 1895: 261).

In 1895 Piette presented a paper at the *Société d'Anthropologie de Paris* titled 'Hiatus and lacuna: Vestiges of the transition period in the grotte du Mas-d'Azil.' In this paper Piette treated the question of a hiatus as settled and used the opportunity to reflect on the origins and main arguments of the debate and to summarize the work at Mas d'Azil that led to his discovery of a transition period in its strata. In looking back on the development of the debate, Piette remarked that two divergent opinions had emerged from Édouard Lartet's initial comment about a discontinuity between the Paleolithic and the Neolithic. One group thought the end of the Pleistocene had brought population displacements, including the arrival of invading Neolithic peoples who brought a new way of living, and that the period of transition between the two periods was brief and without a sharp discontinuity. The other group, 'carried away by their imagination,' argued for an immense period of time separating the Neolithic and Paleolithic and argued that the latter had not given rise to the former (Piette 1895: 235–236).

Piette told the assembled archaeologists and anthropologists that the objective of his many years spent excavating the caves of the Pyrenees was to uncover a stratigraphic record of the progress of industry and of human societies during prehistoric times. This had not only resulted in a much more comprehensive understanding of the Magdalenian period, he wrote, but

it also led to the unexpected discovery of the hitherto unknown transition period that linked the Magdalenian period and the Neolithic. Having long been concerned with reforming the chronological periodization of human prehistory, Piette suggested calling this transition period the Asylien and soon prehistorians began using the term Azilian to refer to this distinctive period and to artifacts and deposits that were being unearthed in other sites as well. There were already other proponents of a transitional period, particularly J. Allen Brown (1893) in Britain, and Piette's discoveries were gradually integrated into a wider body of evidence invoked to support the idea of a Mesolithic period. The argument over a hiatus between the Paleolithic and the Neolithic was resolved but a new discussion arose over defining and describing the Mesolithic.

CONCLUSION

The recognition of the geological antiquity of humans raised many questions for scientists. One of them was how to link the Paleolithic and Neolithic worlds that appeared to differ so greatly. There were valid reasons to suspect that a gap separated them, that climatic changes had wrought profound environmental effects resulting not only in the extinction of many Pleistocene animals, but of late Paleolithic humans (at least in Europe), as well. There were also good reasons to think that Neolithic culture had developed elsewhere, probably the Near East, and was later introduced by these people migrating into Europe. It is significant that both the supporters and the critics of a hiatus invoked geological, paleontological, archaeological, and even anthropological evidence to make their cases. This was typical of other late nineteenth-century scientific debates pertaining to Paleolithic humans. Also typical was prehistoric archaeologists invoking migrations of populations in order to explain the appearance of new artifact types and cultural practices. The proposed migration of Neolithic peoples into Europe at the end of the Ice Age mirrors the widely held theories of Indo-European migrations into Europe that were invoked to explain everything from the introduction of the Bronze Age in Europe to the continent's prehistoric ethnological and linguistic composition. Lastly, the dispute over the hiatus highlights the extent to which the participants presumed that several different events (the geological and climatological end of the Pleistocene, the archaeological end of the Paleolithic (Magdalenian), and the anthropological disappearance of distinctive Paleolithic peoples such as Cro-Magnons all happened at the same time and were causally linked. A complex array of assumptions and conceptions of human prehistory were combined with new empirical evidence to resolve the question of a hiatus, which in turn generated new questions about prehistory and its periodization.

COMPETING INTERESTS

The author has no competing interests to declare.

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TO CITE THIS ARTICLE:

Goodrum, MR. 2021. Resolving the Question of a Hiatus between the Paleolithic and Neolithic: Nineteenth-Century Science and a Problem in Human Prehistory. *Bulletin of the History of Archaeology*, 31(1): 1, pp. 1–12. DOI: <https://doi.org/10.5334/bha-657>

Submitted: 06 November 2020

Accepted: 04 January 2021

Published: 31 March 2021

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