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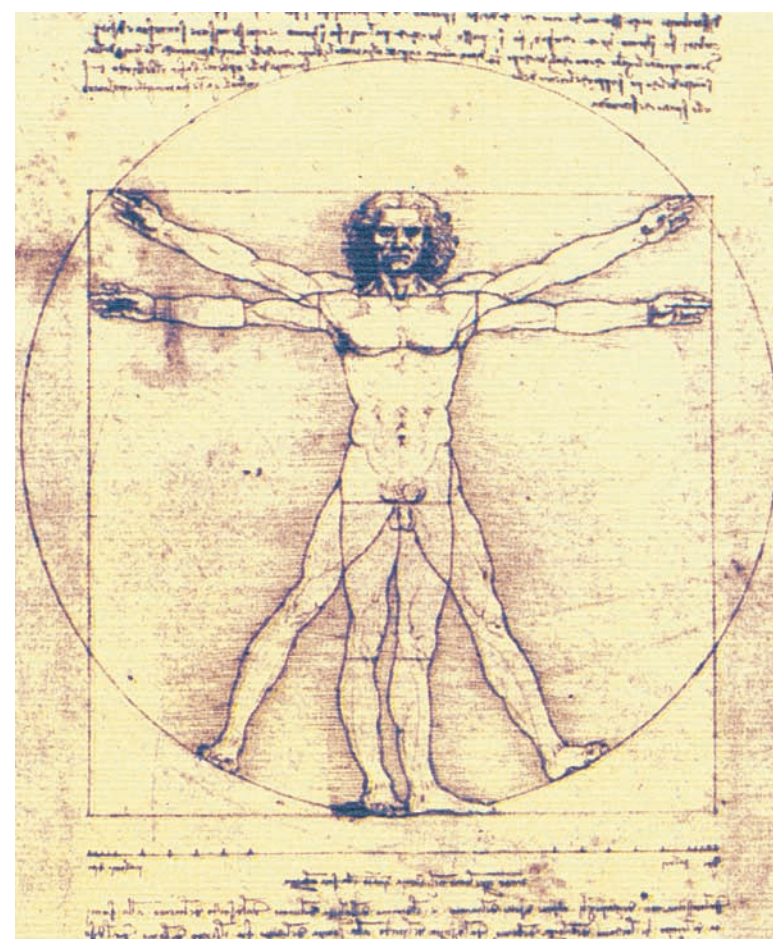
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On cover: Drawing by Leonardo da Vinci (1452-1519) - Study of the human body.

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Using New Anthropological and Biological Tools to Learn about Leonardo da Vinci

INTRODUCTION

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His life marked the rebirth of Western civilization, but no gravestone marks with certainty the final resting place of Leonardo da Vinci. Now using modern techniques, anthropologists and geneticists are seeking Leonardo's remains not simply to mark the spot but also to study and better understand his remarkable abilities and talents. The work underway resembles in complexity recent projects such as the exhumation and reburial of Leonardo's English contemporary, King Richard III, in March 2015 some 500 years after his death.

Like Richard, Leonardo was born in 1452, and like Richard he was given a Christian burial in a setting that underwent changes in subsequent years such that the exact location of the grave became lost. And this is where science and technology come to the aid of history.

In November 2014 an international team of specialists embarked on the first phase of a project to identify conclusively the alleged remains of Leonardo da Vinci at Amboise Castle in the Loire Valley southwest of Paris. They aim to compare DNA yet to be found there with the DNA of Leonardo's father and several close relatives whose remains are buried in Florence, and possibly his mother, in Milan. They hope to acquire an extensive enough genetic profile to understand better his abilities and visual acuity.

The project brings together experts from France, Italy, Spain, the United States, and Canada. Participating organizations include the Institut de Paléontologie Humaine in Paris, the International Institute for Humankind Studies in Florence, the Laboratory of Molecular Anthropology and Paleogenetics at the Biology Department of the University of Florence, Museo Ideale Leonardo Da Vinci in Vinci, J. Craig Venter Institute in La Jolla, California, Laboratory of Genetic Identification at the University of Granada, and the Rockefeller University in New York. Initial support comes from the Richard Lounsbery Foundation in Washington D.C.

Work proceeds along several fronts from Leonardo's family tomb in Florence, to Leonardo's presumed remains at Amboise Castle, and to Milan where there might be the remains of Leonardo's mother, Caterina. Team members are also pursuing traces of

her children by a later marriage. The study team plans to verify whether DNA extracted from the remains at Amboise Castle matches that of remains from Florence and possibly Milan, and traces taken from Leonardo's works of art, drawings, and notebooks and from possible descendants in the area of the town of Vinci, where he was born. Researchers in all these studies are adhering to the latest ethical guidelines for studies in human genomics. The project will verify Leonardo's physical characteristics from historical accounts, portraits and other images, and the cast of a skull attributed to Leonardo. To help further with identification, scholars will verify from historical accounts any illnesses, traumas, injuries, eating habits, and any other physical activities that are likely to have left biomechanical traces on Leonardo's bones (see King, this issue, pp. 133-147).

Leonardo's path from Vinci to Amboise

Leonardo was born in Archiano, a village of Vinci in the province of Florence, Italy, perhaps on 15 April 1452. He was the illegitimate son of the notary Ser Piero di Antonio and the young Caterina, who later married Accattabriga di Piero del Vacca Buti. Leonardo was born in the same year that his father entered into an advantageous marriage with Albiera Amadori, who accepted and reared this healthy and lively boy. In 1457, his name appears in the family records of Antonio Vinci, Leonardo's grandfather, as "illegitimate son."

Near the end of his life, Leonardo accepted an invitation from the French king, Francis I, to leave Italy and to move to the castle of Cloux, near Amboise, with some of his students, where he held the position of "first painter, engineer, and architect of the King." There he was able to devote time to his studies and his projects without having to comply with contractual terms or to fulfill specific obligations.

On April 23, 1519, Leonardo dictated his last will and testament. He died in Cloux on 5 May 1519 (though according to some on 2 May of the same year), at the age of 67. In accordance with his wishes, his mortal remains were buried in the Chapel of Saint Florentin in Amboise Castle. But the burial deeds of the artist bear the date 12 August, which indicates an initial temporary burial of the remains of Leonardo, followed, over three months later, by a final burial in the chapel of Saint Florentin. Here he rested until 1802, when the chapel was demolished and some of the tombs were destroyed and their remains were lost.

Although many of Leonardo's biographies have assigned to his remains this unfortunate fate, in reality there are still many doubts. It is not known for certain whether Leonardo's grave was among those destroyed and scattered. Doubts emerged in 1863 with the excavation of the site where the chapel of Saint Florentin once stood. There between the foundations of the destroyed building, a stone coffin was discovered containing a skeleton with a large skull, judged to be "large enough to hold an exceptional brain" and not far from this coffin a slab with a badly deteriorated inscription, LEO DUS VINC, thought to indicate Leonardus Vincius (see King, this issue, pp. 133-147).

From the skull a cast was made for examination by phrenologists in Paris, but its present whereabouts are unknown. Moreover, the bones attributed to Leonardo, first placed in a basket, were lost, then recovered, and in September 1874 buried in the chapel of Saint-Hubert, in the castle of Amboise, where they should still be today. But though a memorial on the site bears Leonardo's name, an adjacent plaque casts doubt by claiming only "presumed remains."

Tracking Leonardo's relatives

Historical documents attest that during the years 1472-74, Leonard's father, Ser Piero di Antonio, purchased a tomb below the floor of the Badia Fiorentina, the Florentine abbey (Santa Maria Assunta), situated in the very heart of Florence across the street from the Bargello, now an art museum. The Badia Fiorentina is the oldest monastery in the city and was founded in 978 for monks who followed the Rule of St. Benedict. Today the Badia is home to the Fraternity of Jerusalem. Thus far, reliable documentary evidence shows that at least fourteen of Leonardo's blood relatives were laid to rest in the Badia, including Leonardo's father and adult half-brothers by his father's third and fourth wives, as well as another illegitimate brother by an unknown mother (see Leader, this issue, pp. 149-158).

Records in the Florence State Archives and national library have been particularly useful when trying to identify the exact location of tombs or burial sites, including Badia tomb registers compiled in the seventeenth century, and contemporaneous accounts written by the abbey's historian and abbot. These volumes generally contain not only information derived from both official and public documents but also details provided by the churches, therefore affording additional clues because the positions of the tombs are often referred to in relation to the internal features of the church at that time. This information assumes greater importance in light of the many transformations that the Badia has undergone over the course of centuries. We know that the monastery was expanded toward the end of the 1400s. In 1627 the orientation of the church was rotated by 90 degrees and the entrance became what had previously been the apse. The present entrance was opened in 1494. Moreover, in 1663 the floor of the Badia was completely repaved, and all of the tombstones were removed, leaving no physical indication of the former locations of the various tombs. In the absence of many of the church's original features mentioned in official records, Anne Leader (this issue, pp. 149-158) has reconstructed from documented sources the original plans and features of the church, and all ensuing transformations, to discover the likely location of Leonardo's family's remains.

Concurrent with this search, another investigation was underway using ground penetrating radar, the noninvasive tool used to find the remains of Richard III beneath a parking lot and those of Miguel de Cervantes in a long-lost crypt (<http://www.bbc.com/news/world-europe-31869746>). Geological technologists from the University of Siena

scanned the floor of the Badia early in 2015 and found electromagnetic anomalies consistent with that of tomb chambers (see Minucci & Colonna, this issue, pp. 159-168). Their survey, in concert with analysis of historical records by Anne Leader on behalf of the International Institute for Humankind Studies, supports a request for permission to excavate and expose the remains of Leonardo's relatives for exhumation and DNA analysis in the second phase of the project.

The remains of Leonardo's mother present an alternative route to identifying his remains by DNA analysis, but that route is obscure. Annotations found in Leonardo's notebooks refer to expenses incurred for the treatment and funeral of "Caterina," an otherwise unidentified woman who died on 26 June 1494 in the parish of Santi Nabore e Felice in Milan. However, there is no indication of the exact place of burial, neither are there bibliographical sources to suggest that its whereabouts have ever been investigated.

Museo Ideale Leonardo Da Vinci and the J. Craig Venter Institute, on another track, are advancing Leonardo's genealogy from historical sources to construct a family tree with Progeny software. Given that the Y-chromosome DNA haplogroups (inherited through the paternal line) and the mitochondrial DNA haplogroups (inherited through the maternal line) are the same from generation to generation except for any mutational events that may have occurred, it may be possible to trace surviving relatives from the paternal line and the maternal line to obtain DNA samples for eventual comparison to the genetic material obtained from exhumed remains or pieces of art. The Museo Ideale Leonardo Da Vinci will also seek to locate possible descendants of Leonardo near the town of Vinci (see Vezzosi, this issue, pp. 169-189) so that the team can compare their genetic profiles to DNA obtained from Leonardo's remains.

Artwork and fingerprints

It is well known that Leonardo used his fingers along with his brushes while painting, some prints of which have remained, and so it could be possible to find cells of his epidermis mixed with the colors. The Leonardo Project seeks to verify whether fingerprints obtained from Leonardo's paintings, drawings, and notebooks can be compiled and eventually attributed to him. A more general objective is to verify whether DNA extracted from traces taken from Leonardo's works of art and manuscripts are consistent with DNA extracted from identified remains.

In January 2015, the International Institute for Humankind Studies opened discussions with the laboratory in Florence where Leonardo's *Adoration of the Magi* has been undergoing restoration for nearly two years to explore the possibility of analyzing dust from the painting for possible DNA traces. In preparation for such analysis, a team from the J. Craig Venter Institute will examine contemporaneous paintings from a private collection to develop and calibrate techniques for DNA extraction and analysis. If human DNA is obtained from Leonardo's work and sequenced, the genetic material can then be

compared with genetic information from skeletal or other remains that may be exhumed in the future.

Experts in forensic genomics plan to design inhibition and sensitivity experiments to study different pigments and resins used in Leonardo's day to determine if the chemicals and materials of which these paints and resins are composed are likely to allow for successful amplification and detection of trace human DNA.

A conservative approach

The analyses necessary to identify the remains of Leonardo must be as conservative as possible. The enterprise must not arrive at the identification of his remains, only to have destroyed what was left. Therefore, any analysis that could possibly result in the destruction or impairment of even minimal skeletal portions must be evaluated beforehand both qualitatively and quantitatively to assess the importance of the contribution that such an analysis is likely to provide for the investigation.

With this precaution in mind, work will proceed in phases, beginning with obtaining permission for excavation to access remains at the Badia Fiorentina. Similar excavations have been done several times before, recently at the Medici Chapels in Florence to unearth members of the Medici family. Historical study is needed to reconstruct events that may have affected the remains of Leonardo, from the place of his alleged death to their present location. Already information has been gathered from literature about Leonardo's physical characteristics, from age at death to stature, size, degree of robustness, and other physical and physiognomic traits. For example, Leonardo would have been exposed either in his studio or his workshops to lead, mercury, and other chemicals that would leave lasting traces (see King, this issue, pp. 133-147).

When permissions are obtained, physical anthropological analysis can begin with the exhumation of bone samples from remains thought to be those of Leonardo and his direct blood relatives. Investigators will extract DNA to assess whether its quality is sufficient for further forensic analysis and genetic interpretation. Radiometric dating of the finds by carbon-14 and other methods would show whether the indicated time of death corresponds with the established date of the bones. Research must verify whether the physical characteristics reported of Leonardo, such as his left-handedness, physical strength, and handsome appearance, are compatible with those ascertained from the study of skeletal remains, such as sex, stature, and facial features. Further, is evidence found from the bones compatible with Leonardo's reported illnesses, injuries, and eating habits? (e.g. Leonardo is thought to have followed a vegetarian diet for much of his life). Finally, superposition of radiographic and photographic images will help to assess any similarities between the facial skeleton and Leonardo's portraits and any other iconographic representations, such as the skull cast.

In conjunction with approaches from physical anthropology, the project can proceed to DNA analysis for comparison of the genetic profiles obtained from samples extracted from the alleged bones of Leonardo and those of his relatives. If DNA analysis yields a definitive identification, then conventional and computerized techniques might reconstruct the face of Leonardo from the real and virtual models of the skull and from the possible death mask, reportedly in Paris, made at the time of Leonardo's passing. If found, the death mask could also yield precious DNA.

With regard to Leonardo's artwork, investigators must identify and obtain permission to examine paintings that have retained fingerprints and notebooks that may have retained his skin cells. Then a crucial question is whether traces of DNA remain or whether restoration measures and the passage of time have obliterated all evidence of Leonardo's touch.

“Vissi d'arte”

Indeed it is Leonardo's art and creative genius that inspire the search for his bones, and it is to the history of art and the creative process that the search could leave an important legacy. Leonardo's reputation as a painter rests on a handful of paintings, while other works were not completed or were planned and not begun. Experts debate the authenticity of works attributed to Leonardo, such as a portrait of Isabella D'Este, lost for 500 years before it was purportedly identified in a private collection in 2013 (<http://www.theguardian.com/artanddesign/2013/oct/04/leonardo-da-vinci-lost-portrait-isabella-deste>) or the so-called *Bella Principessa*, identified as by Leonardo in 2008, but claimed to be a forgery in 2015 (<http://theartnewspaper.com/news/news/could-leonardos-bella-principessa-be-greenhalgh-s-bolton-sally-/>). DNA samples matched to others found in Florence (or Milan or Amboise) could serve as a reference standard for authenticating disputed or unidentified works of Leonardo. Scrutiny of Leonardo's art may also improve approaches to other forensic DNA studies.

Studying DNA traces in Leonardo's artwork could improve techniques for extracting and sequencing DNA from other centuries-old works of art, and associated methods of attribution. Art forgery is a multi-billion-dollar industry that depends on falsifying or confusing the attribution of artworks to their creators. Authentication of contemporary artworks, just as for Leonardo's, sometimes depends on consensus among interested parties rather than more definitive means. What if artists and dealers had at their disposal an inexpensive, indelible, and tamper-proof label with which to identify their work? Such a label developed by the University of New York at Albany makes use of synthetic DNA to create a genetic signature that permeates a work of art, invisible and undetectable until needed (http://www.nytimes.com/2015/10/13/arts/design/developing-dna-as-a-standard-for-authenticating-art.html?_r=0). It is an idea that Leonardo, who famously invented a sort of shorthand writing in reverse perhaps to protect his written ideas from theft, would embrace.

Summary

The search for Leonardo's death mask and remains at Amboise Castle, for the remains or traces of his family members in Florence, Vinci, and Milan, and for traces of his DNA in his works is fraught with difficulty. Matching Leonardo's DNA to that of his family presents puzzles that are minutely specific to their history and circumstances, but the tools the investigators use are generic and broadly applicable. We stand to gain not only greater historical knowledge of Leonardo but possibly a reconstruction of his genetic profile, which could provide insights into other individuals with remarkable qualities. The last Plantagenet king of England and the author who gave us Don Quixote are two whose places in history are somewhat better documented now through recent anthropological study. Is Leonardo the next?

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Leonardo's Bones: Myth, History, and Evidence

A plaque declares the bones entombed in the chapel of Saint-Hubert, in the Château d'Amboise in the Loire Valley, to be the "presumed remains" of Leonardo da Vinci, who died in Amboise at the age of sixty-seven in 1519. The remains in the chapel were excavated nearby in 1863 by the novelist, art critic and impresario Arsène Houssaye. Even by the standards of the mid-nineteenth century, Houssaye's protocols were short on science and strong on myth and wish fulfilment. Doubts about his methodology were raised soon after his discovery and supposed identification of the bones. The uncertainty endures, but scientific study of the remains could be expected either tentatively to confirm or to preclude altogether the possibility of their being those of Leonardo da Vinci. They could be expected to accord with certain known information about his diet, fitness, state of health, personal habits, places of residence, and physical appearance – ambiguous and inconclusive as the evidence sometimes appears. The remains might also be expected to exhibit several anomalies, including evidence of the chemicals and minerals to which his career as a painter and inventor exposed him, such as lead, arsenic, mercury, oxides of aluminium, zinc and manganese. Moreover, although his family on his father's side came from Tuscany, information about his mother is much scarcer. One theory is that she was a slave, which means that her ethnic origin may have been in the North Caucasus region of present-day Russia, the area from which women were taken to Italy as slaves. If authentic and amenable to scientific investigation, the remains in Amboise might therefore be expected to reveal valuable information about an elusive and enigmatic figure.

KEY WORDS: *Leonardo da Vinci, Arsène Houssaye, Château d'Amboise, physical remains, archaeology, appearance, self-portraits, sexuality, health.*

Introduction

In the summer of 1863, Arsène Houssaye arrived in Amboise, 220 kilometers southwest of Paris, in the Loire Valley. The 48-year-old Houssaye was a successful and ubiquitous "man about Paris" (as he entitled his memoirs): a wealthy theatre director, poet, newspaper editor, art collector, and novelist. Since 1857 he had served as the inspector-general of France's provincial museums, and it was in this capacity that he was charged by the government with the task of locating in Amboise the tomb of Leonardo da Vinci.

Houssaye's mission appeared to be a difficult if not impossible one. Following his death in 1519, Leonardo had been interred in the royal collegiate church of Saint-Florentin. However, religious battles during the latter half of the sixteenth century, followed

two centuries later by the depredations of the French Revolution, meant the exact site of the tomb had long since been lost. In 1808, on orders of Pierre-Roger Ducos, proprietor of the Château d'Amboise, Saint-Florentin itself had been demolished. Many of the tombstones were sold off, the lead from the coffins was melted down, and the local children played games of *boules* with the scattered skulls and bones. Indignant at these desecrations, a gardener, a certain Goujon, rescued some of these remains and interred them beneath what had been the church's choir (Houssaye, 1869).

More than five decades later, in June 1863, sped on his way with the good wishes of the Emperor Napoleon III and other of Paris's political and artistic worthies, Houssaye arrived on the banks of the Loire to begin his search for Saint-Florentin's foundations and Goujon's hastily improvised ossuary. Among his labourers was an old man who claimed to remember walking as a child on Leonardo's tomb slab in the choir of the church. He was further assisted by the daughter of Goujon, who directed him towards a cherry tree whose fruit, she informed him, grew so prolifically because it was nourished by human remains. Even less plausible help was offered by a nonagenarian who claimed to have seen Leonardo walking the streets of Amboise, and who, in "mysterious phrases," intimated that he knew the site of the tomb (Houssaye, 1869). He directed Houssaye to a tomb in a cemetery that, once the weeds were cleared, proclaimed: "Ci-gît Léonard, artiste peintre" (Here lies Leonardo, artist and painter). However, on investigation this particular Léonard proved to be a local, "an obscure dauber" who had once worked at the Château d'Amboise (Houssaye, 1869; *Le Petit Parisien*, 12 August 1906).

Notwithstanding these somewhat dubious leads, Houssaye's excavations quickly produced results. On the second day he discovered what he believed to be Goujon's ossuary, which included a skull he deemed worthy of study because its shape and age recalled, according to his casually unscientific methodology, "the beautiful head of Leonardo da Vinci." Yet Houssaye was not entirely convinced. Then, some two months later, on August 20, his workers uncovered at the base of the fabled cherry tree, which grew in what had been the choir of Saint-Florentin, another promising candidate: a skeleton whose skull rested on its hand "such as during sleep... The beautiful brow seemed still inhabited by meditation." Houssaye confessed that during his excavations he had "awakened many dead in their tombs," but none had given evidence of a skull "so masterfully designed for intelligence or, rather, by intelligence." The forehead was wide and high, the occipital arch ample and pure: it was the perfect vessel, Houssaye claimed, for "the man who held the world in his brain." The skull compared favourably with a portrait of Leonardo in which the artist's balding pate allowed Houssaye to "strictly follow the pattern of his head." Doctors quickly confirmed that it was the skull of a septuagenarian (although Leonardo had died, in fact, at 67), and that the deceased had stood 5-feet 5-inches tall, "recalling the height of Leonardo." Houssaye showed the skull to Joseph Nicolas Robert-Fleury, director of the French Academy in Rome. Robert-Fleury reverently touched the skull, extolling "the proud and pure design of this divine human head that encompassed an entire world."

This same gravesite yielded other clues: Italian coins, a silver shield with an apparent likeness of Leonardo's patron, King François I, a pair of sandals preserving the imprint of the owner's toes, and a few strands of hair, greyish-blond in colour. These relics were "piously transported" to a room in the Château d'Amboise, from which, in the absence of adequate safeguards, the coins promptly disappeared that same evening. Houssaye made no mention of the eventual fate of the other tantalizing objects, such as the sandals or the strands of hair (which he speculated might have come from Leonardo's beard). Meanwhile, a gardener from the château found, "a little farther away," several fragments of stone, on one of which was carved "INC," and on the other, uncovered two meters away, "LEO." Further excavations soon produced a third fragment carved with the name of Saint Luke – the patron saint of artists – and yet another decorated with arabesques and inscribed "EO DUS VINC." The pieces of this stone puzzle appeared to spell out the name of Leonardo da Vinci.

"For those who attended the excavations, as for me," Houssaye triumphantly concluded, "the evidence spoke loudly of the tomb of Leonardo da Vinci." Leaving aside the somewhat messy details, the *Revue Artistique et Littéraire* (Vol. 5, 1863) quickly reported that Houssaye had discovered a grave whose inscription "leaves no doubt... about the authenticity of the remains contained therein." Yet doubts were raised about Houssaye's approach within a decade of his investigations. The geologist and Leonardo scholar Gustavo Uzielli deplored Houssaye's "fantastic considerations on the skull of Leonardo," which, along with the somewhat haphazard archaeology, were bound to awaken, he believed, suspicions about the integrity and reliability of the investigation (Uzielli, 1872). In 1906 a French newspaper reported that Houssaye's excavations did not convince everyone, that they had been undertaken in a spirit of romanticism rather than scientific investigation, and that a new search for Leonardo's resting place was about to commence. The newspaper predicted "some interesting archaeological discoveries," but none were forthcoming (*Le Petit Parisien*, 12 August 1906).

It is easy to join the doubters about the reliability of Houssaye's excavation of the bones that, since 1874, have been entombed in the chapel of Saint-Hubert, in the precincts of the Château d'Amboise. The tomb slab is emphatically inscribed LEONARDO DA VINCI, although a plaque reports more cautiously that here lie the "presumed remains" (*restes présumés*) of Leonardo, discovered during excavations in 1863.

The ambiguity and conjecture are appropriate and perhaps inevitable. Despite his immense fame, Leonardo is an elusive and enigmatic figure. In contrast to contemporaries such as Michelangelo, surprisingly little is known about his life. The dispersal of his remains and their subsequent "recovery" by Houssaye – a procedure short on science and strong on myth and wish fulfilment – can serve, perhaps, as a metaphor for Leonardo's legend, which often proliferates at some remove from the spare historical facts. Documentary evidence regarding his life and appearance is disappointingly scanty and often frustratingly vague and inconclusive. It is possible, however, to reconstruct certain aspects of his life to ascertain information about his diet, health, fitness, personal habits,

places of residence, and physical appearance. Such evidence derives from contemporary descriptions, several portraits or self-portraits, the evidence of his notebooks, and other contemporary sources. This evidence, partial though it is, may have some bearing on the “presumed remains” of Leonardo interred at Amboise.

Study of the remains at Amboise might be expected to show several anomalies. First of all, as a painter and inventor, Leonardo was exposed to a number of chemicals and minerals such as lead, arsenic and mercury, and his pigments were made from oxides of aluminium, zinc and manganese. Tests could be expected to find higher than average levels of all of them. However, there is no evidence that Leonardo ever suffered from any toxicity such as lead poisoning – an occupational hazard for painters.

Second, although Leonardo’s family on his father’s side came from Tuscany and can be dated as far back as the 1330s, information about his mother is much scarcer. One intriguing theory is that she was a slave, which means that her ethnic origin (Circassian or Tatar) would have been in the North Caucasus region of present-day Russia, the area from which women were taken to Italy as slaves. Another (lesser) possibility is that she came from North Africa.

Ancestry and upbringing

Leonardo’s father was a notary, Ser Piero da Vinci (b. 1426). The family had lived in Vinci since at least the 1330s. Leonardo was born illegitimate, and his mother was a 16-year-old named Caterina. Little is known of Caterina, though it has been speculated that she may have been a slave (Cianchi, 2008). The theory is worthy of consideration. Many Tuscan families in the fifteenth century used female slaves as domestics, and many of these slaves gave birth to the illegitimate children of their masters or their masters’ sons. Most of the slave girls originally came from the Caucasus, north of the Black Sea in present-day Russia and Georgia; others were of North African extraction (Origo, 1955). Circassian women were especially prized because of their beauty and their fair complexions.

In 2007 Professor Luigi Capasso of the University of Chieti, having reconstructed one of Leonardo’s fingerprints, claimed that it featured a central whorl that was a common pattern in the Middle East. However, it is difficult to know what to make of this claim. In the first place, the vast majority of slaves in fifteenth-century Italy did not come from the Middle East. Secondly, fingerprint patterns do not contain reliable information about an individual’s racial and ethnic origins (Rabinow, 1993). Caterina went on to have five other children after Leonardo – four daughters and a son – and lived in humble circumstances in Campo Zeppi, near Vinci.

Leonardo’s family was affluent by the standards of rural Tuscany in the middle of the fifteenth century. The family owned significant property, including a farm at Costereccia, not far from Vinci. The family had been notaries for five generations, often doing

business in Florence, where Leonardo's father Ser Piero would by the 1460s become a notary for the government, the Jewish community, and many convents. Given this affluence, Leonardo could have been expected to have enjoyed a good diet. There are no reports of childhood illnesses or injuries.

Appearance

Portraits/Self-Portraits

Leonardo da Vinci is one of the most famous people in history for whom we have scanty and unreliable visual evidence. Or, rather, we have a plethora of evidence: Vezzosi and Sabato (2009) recently catalogued 106 purported portraits and self-portraits. However, very little of this pictorial evidence is entirely reliable.



Figure 1. Melzi Portrait, Royal Collection Trust/© Her Majesty Queen Elizabeth II 2016.

Melzi Portrait (Royal Collection, Windsor Castle).

This is the only depiction of Leonardo unanimously accepted as a portrait likeness. It is attributed to his pupil and close friend Francesco Melzi (c.1490-c.1570). As the only undisputed portrait of Leonardo, it can serve as a touchstone for other supposed portraits and self-portraits. However, it has been dated to c. 1515-18 (Clayton, 1996), when Leonardo was in his mid-60s, so it tells us little about the appearance of the young Leonardo. It may have been the source for descriptions (by Vasari et al.) of Leonardo's long beard and handsome physical appearance. It may be somewhat idealized given that Antonio de Beatis, who met Leonardo at Amboise in 1517, around the time the portrait was drawn, believed the painter to be "an old man of over seventy" (Beatis, 1979). The Melzi portrait does, however, show a man with a high brow, a handsome Greek nose, abundant hair

and – from what we can determine – most or all of his teeth. The loss of teeth would have been the most serious impairment to a handsome appearance, and so perhaps we could conclude that Leonardo’s teeth remained in a good condition throughout his life. Houssaye’s skeleton, when disinterred in 1863, had only eight teeth: four upper and four lower. Nowhere in his notebooks does Leonardo mention remedies for toothache or anything that might indicate dental problems.

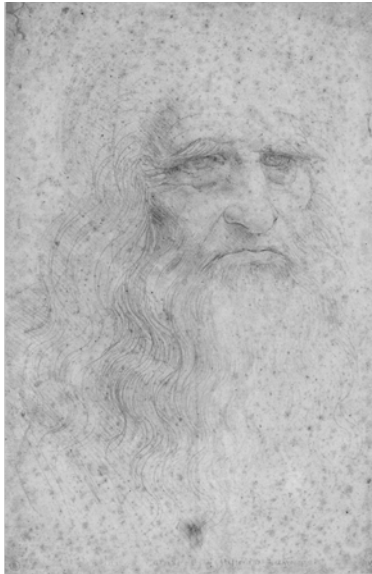


Figure 2. Leonardo, self-portrait, reproduction courtesy of the Ministero dei Beni e delle Attività Culturali e del Turismo, Biblioteca Reale, Turin.

“Self-Portrait” (Biblioteca Reale, Turin).

This famous sketch was long regarded as Leonardo’s self-portrait in old age. It is without doubt the drawing used by Houssaye in his comparative analysis of the skull at Amboise. However, based on its style and medium, scholars have dated it to the mid-1490s, casting serious doubt on whether it could be a self-portrait (Bodmer, 1931; Brown, 1994). Others have even rejected that it was done by Leonardo (Ost, 1980; Wallace, 2010). Vezzosi and Sabato (2009) maintain that it features “a quality of execution which excludes the hypothesis of a forgery,” but Wallace, to the contrary, contends: “The Turin drawing is not of high quality, it is not from the Renaissance, it is not *by* Leonardo, and it is not *of* Leonardo.” It possesses a suspect provenance, having appeared only in the 1830s, in the collection formerly owned by a known forger, Giovanni Battista Volpato. Its status as a likeness of Leonardo must be regarded with caution and even suspicion.



Figure 3. Andrea del Verrocchio's *David*, reproduction courtesy of the Gabinetto Fotografico, Polo Museale Regionale della Toscana.

Andrea del Verrocchio's David (Museo Nazionale del Bargello, Florence).

Many attempts have been made to identify Leonardo as the model for Verrocchio's bronze *David*. The recent redating of the bronze to c. 1466-9 (Butterfield, 1997), a period when Leonardo was an adolescent in Verrocchio's workshop, makes the identification plausible but not definitive. An argument in favour has been made by Brown (1998), but the connection is disputed by Clayton (1996). However, if we can accept Verrocchio's *David* as an accurate likeness of Leonardo, then it might also be possible to posit the figure of Thomas in Verrocchio's bronze sculpture group *The Incredulity of St. Thomas* (Orsanmichele) as another likeness, done some ten years later when Leonardo was in his mid-20s. The resemblance between the two figures is remarkable.



Figure 4. Leonardo (attrib.), Lucanian self-portrait, reproduction courtesy of Nicola Barbatelli, Scientific Director, Museo delle Antiche Genti di Lucania.

Lucanian Self-Portrait (Museo delle Antiche Genti di Lucania).

Rediscovered in southern Italy in 2008, in the possession of a family who believed it to be a portrait of Galileo, this work has been put forward by Nicola Barbatelli and others as Leonardo's self-portrait. It appears to share some relationship with the painting that entered the Uffizi in 1715 and that was accepted as Leonardo's self-portrait until 1938, when it was discovered to have been done during the seventeenth century. Radiocarbon analysis and X-ray fluorescence have dated the Lucanian work to the early sixteenth century (Barbatelli & Capasso, 2010). Barbatelli has argued for it as the prototype of the painting in the Uffizi, identifying it with a Leonardo self-portrait that, according to an eighteenth-century report by Baldassarre Oltrocchi, one of the artist's relations gave to Cardinal Salviati in 1536 (Barbatelli & Hohenstatt, 2012). However, other experts, such as Alessandro Vezzosi, deny the possibility that it is an autograph self-portrait while noting its importance only "as a new element in an unfinished mosaic reconstructing the evolution of the image and myth of Leonardo's face" (Vezzosi & Sabato, 2009).

The painting shows, intriguingly, a man with blue eyes and light brown hair. Blue eyes would have been unusual but by no means unknown in Italy: Nero had blue eyes, while Caesar apparently derives from the Latin word *caesius*, blue-eyed (Günther, 1957). Christopher Columbus and Antonio Canova are both reported to have had blue eyes. It

is possible that, if the portrait does indeed show Leonardo, the many comments on his handsome features are a reference to these fair and, in Italy, somewhat atypical features. That blue eyes and fair hair represented a fifteenth-century Italian ideal of beauty (feminine beauty at any rate) can be seen in numerous portraits of women in the fifteenth century, such as Domenico Ghirlandaio's portrait of Giovanna Tornabuoni (1488; Thyssen-Bornemisza Museum, Madrid), which emphasize blonde hair and blue eyes.

In this context it might be worth noting – with the appropriate caution – the comments of Ludwig Woltmann in *Die Germanen und die Renaissance in Italien* (The Germans and Renaissance Italy), published in 1905. Woltmann argued that many famous Italians of the fifteenth and sixteenth century, including Leonardo, were of Nordic (particularly Germanic) descent, his deductions coming from pictorial and textual testimony about eye and hair colour. There is good reason to be suspicious of Woltmann's political agenda: his racial theories about the intellectual preeminence of Aryans (who, in his argument, supplant the Italians as the begetters of the Renaissance) were easily adapted to Nazi thinking. The Library of Congress holds Hitler's personal copy of Woltmann's book. However, his assertions do indicate that the genetic makeup of Italians is complex.

Descriptions of Leonardo

A number of commentators offer descriptions of Leonardo's appearance that stress his physical beauty. The earliest mention of Leonardo's appearance comes from a poem written in about 1498 by Gasparo Visconti, who knew Leonardo personally. His poem is a lampoon which no doubt exaggerates for comic effect, but it does stress that the painter about whom he writes – unnamed but almost certainly Leonardo – rejoices in a handsome appearance (Kemp, 2006). However, no specific details of his features are given. A short while later, in a poem published in 1509, a French poet, Jean Lemaire, described his “supernatural grace” (Nicholl, 2004), though it is difficult to know what kind of physical characteristics, if any, this description might refer to.

Over the next century, a number of other descriptions of Leonardo were published:

- “His face was extraordinarily beautiful” (Paolo Giovio)
- “He was striking and handsome” (Giorgio Vasari)
- “He was attractive, well proportioned, graceful and good looking. His hair came to the middle of his chest, and was well-dressed and curled” (Anonimo Gaddiano)
- “He had long hair, long eyelashes, a very long beard, and a true nobility” (Giovan Paolo Lomazzo)

Nicholl (2004) extrapolates from them that Leonardo was “handsome, tall and imposing.” However, there are no direct references in the sources to Leonardo's height. Although Houssaye (1869) clearly puts the height of the skeleton in Amboise at 5-feet, 5-inches, Sweetser (1878), citing Houssaye, inexplicably gives Leonardo a loftier stat-

ure, raising the height of the skeleton to 5-feet, 8-inches – a good example of the way in which Leonardo expands to fill the commodious space offered by myth.

It should be noted that the authors of two of the accounts, Vasari and Lomazzo, never met Leonardo. However, 30 years after Leonardo's death, Vasari had contact with some of his friends and servants, and he appears to have seen the Melzi portrait (now in the Royal Collection, Windsor). Giovio did meet Leonardo, and the Anonimo Gaddiano may have done so. All or some of these descriptions may be based on the Melzi portrait. It should be noted that Leonardo was unlikely to have worn a beard before about 1510, the point at which Europeans began adopting facial hair.

Traits

Physical Strength

Giorgio Vasari states that Leonardo was “so strong that he could withstand any violence,” and that he could bend a horseshoe and the iron ring of a doorbell. There is no reason to accept these claims, which appear to have been invented by Vasari in order to make Leonardo a more heroic figure. However, Leonardo seems to have been physically fit and active for much of his life (see below: Physical Fitness).

Lefthandedness

The fact that Leonardo was born left-handed was attested by his close friend and contemporary Fra Luca Pacioli, who described how the illustrations in *Divine Proportion* were done by “the incredible left hand ... of the prince of all human beings, that great Florentine, Leonardo da Vinci” (Pacioli, 1509). Lefthandedness was highly unusual in the fifteenth century because parents freed the child's right hand first from the swaddling clothes in hopes that he would begin using and strengthening the right rather than the left hand (Boyle, 1998).

Richter (1970) conjectured that Leonardo became left-handed by necessity after a childhood injury to his right hand. Popham (1946) likewise speculated that a childhood accident maimed Leonardo's right hand: Popham and Richter are simply attempting to explain the mystery of Leonardo's lefthandedness, and there is no evidence of any kind of accident. If Leonardo's right hand was in some way disabled, it is more likely that it was the result of a stroke later in life (as the 1517 testimony of Antonio de Beatis suggests). His lefthandedness seems to have been natural rather than enforced.

Sexuality

In April 1476 Leonardo was anonymously denounced, along with three other young men, for having sexual relations (sodomy was specified) with another young man named Jacopo Saltarelli. A sexual relationship with his long-term companion Salai (Gian Giacomo Caprotti di Oreno) was posited by Gian Paolo Lomazzo in *Gli Sogni e Ragiona-*

menti (Dreams and Arguments), written in 1560. Lomazzo was born in 1538, almost two decades after Leonardo's death. He therefore had no actual knowledge about the relationship between Leonardo and Salai, apart from hearsay and speculation, though he claimed to have spoken with some of Leonardo's former servants. There is no evidence that Leonardo ever had sexual relations with women, and there is little reason to doubt that Leonardo was a practising homosexual.

Health

Physical Fitness

Leonardo appears to have been physically active for much of his life, in particular through his hiking and climbing expeditions. His notebooks contain references to 40 different types of trees and some 100 species of plants, while mountains are mentioned more than 200 times. These indicate his love and knowledge of the countryside. His earliest surviving drawing is a landscape that shows a conical hill, Monsummano, that was eight miles from Vinci. He appears to have walked extensively in both the Tuscan hills and later the Alps and the Dolomites. His notebooks refer to his having climbed to "the top of a high mountain" (Richter, 1970, §302). He describes in some detail his ascent of a mountain in the Alps, which he calls Monbosco, and which Kirchner (1950) identifies as Monte Bo, a 2,556 m (8,386 ft) peak. Leonardo writes that he climbed above the treeline to a point where ice and snow could still be found in July. Around the time of his 40th birthday, in the early 1490s, he climbed extensively in the area around Lake Como. His notebooks also make a number of references to Mount Etna in Sicily that indicate his familiarity with the volcano and its eruptions, though there is no other evidence that he went to Sicily, let alone climbed Etna.

Interest in Diet and Health

Leonardo seems to have been concerned with health and fitness despite the fact that until the last four years of his life there are no hints of any major illnesses. He owned a number of books on diet, health and hygiene: *De la Honesta Voluptate et Validudine* (On Honorable Pleasure and Health) by Bartolomeo Sacchi (known as Platina), who offered his readers "good health and a clean life;" and *The Salernitan Rule of Health* by the medieval alchemist and astrologer Arnaldus de Villa Nova. He also owned a book called *On the Preservation of Health*. One of Leonardo's notes reads: "Maestro Giuliano da Marliano has a fine herbal. He lives opposite to Strami the Carpenters" (Richter, 1970, §1386). He does, however, appear to have been suspicious of doctors and medicine. He claimed the doctors used medicines that were the "work of alchemists" (Richter, 1970, §856).

In about 1515 Leonardo wrote out a series of prescriptions for good health: do not eat when you have no appetite, chew food well, use simple ingredients, do not take medi-

cine (which indicates his suspicion of doctors), do not sleep in the middle of the day, mix wine with water, do not take strenuous exercise, and “avoid wantonness.”

Vegetarianism

Leonardo was known as a vegetarian by 1516, when an Italian traveller to India, Andrea Corsali, wrote home to Giuliano de' Medici, the son of Lorenzo the Magnificent, that the Gujurati did not feed on anything that has blood, “like our Leonardo da Vinci” (Nicholl, 2004). Vegetarianism was not unusual in fifteenth- and sixteenth-century Italy: the Dominicans and Franciscans both abstained from meat. However, as the traveller's comment indicates, it was uncommon enough among the public at large to make Leonardo notable in the eyes of at least one contemporary. It is not known for how long Leonardo practised vegetarianism. One of his shopping lists from 1504 mentions “good beef” (Richter, 1970, §1548), though the purchase may have been made for his apprentices rather than for himself. His writings show many examples of his sympathy with animals and his objections to their mistreatment by humans (Richter, 1970, §1295). Some of these appear to date from the early 1490s, and so it is possible that his vegetarianism dated from the time he was aged 40 or younger. One of his typical shopping lists itemizes beans, white maize, red maize, millet, buckwheat, kidney beans, green beans, and peas (Richter, 1970, §1521). He owned Platina's cookbook, *De la Honesta Voluptate et Valitudine*, which included a number of vegetarian recipes.

Use of Lead White

Leonardo used large quantities of lead white in works such as *The Last Supper* (1494-98) in Milan and his unfinished *Battle of Anghiari* (1504-6) in Florence. For example, for *The Last Supper* he covered a wall 15 feet high x 30 feet wide with a base coat of lead white. An undated note records that he once purchased “60 pounds of white,” presumably lead white (Richter, 1970, §1540). Lead white was poisonous, and lead poisoning was an occupational hazard for painters. Moffitt (1998) and Britton (2003) have linked the madness and melancholy of many painters to the effects of lead poisoning. In 2000 the palaeontologist Francesco Mallegni announced that remains discovered in Florence and believed to be those of Giotto (c.1266-1337) showed high levels of lead. Similarly, in 2010 Silvano Vinceti announced that bones believed to be those of Caravaggio (1571-1610) revealed lead at toxic levels. Leonardo's remains could be expected to have similar levels of lead, as well as other minerals such as orpiment, arsenic, aluminium, zinc and manganese (see below). However, despite Leonardo's use of large quantities of lead white, he seems not to have suffered any ill effects, either physically or emotionally.

Use of Mercury, Arsenic, and Orpiment

Leonardo's residence in the Corte dell' Arengo in Milan (which he occupied throughout the 1490s) appears to have had a well-equipped laboratory in which he experimented with various oils, minerals and chemicals in order to perfect pigments and glazes, as well as to determine a method for casting the giant bronze equestrian monument to Francesco Sforza. There are two references to the use of arsenic in his notebooks. Another substance that he evidently handled, orpiment, used to make a yellow pigment, was likewise poisonous. He also experimented with mercury. However, as with white lead, there is no indication that he suffered any ill effects from handling these substances.

Leonardo mentions mercury in a recipe for making a varnish (Richter, 1970, §637), which he proposes to create from a combination of mercury, iron, copper and lead. For some reason he was concerned to keep the recipe a secret since this is one of the very few notes written in a code.

One of Leonardo's other notes (Richter, 1970, §642) gives a list of ingredients that he planned to use for unspecified purposes: nitre, vitriol, cinnabar, alum, salt ammoniac, sublimated mercury, rock salt, common salt, rock alum, arsenic, realgar, orpiment, and verdigris. The last four items in this list would have been used for making pigments and glazes.

Leonardo's instructions for how to prepare a wooden panel for painting (Richter, 1970, §628) stipulate that one should coat it with mastic and turpentine, then with a coat of aqua vitae in which arsenic has been dissolved. If Leonardo prepared all his panels in this way, we could expect him to have handled arsenic on 15-20 occasions, and more often if he assisted his various pupils with their own work.

Leonardo's Illness in 1515

Leonardo seems to have enjoyed good health for much of his life. However, in the summer of 1515, while living in Rome, he mentioned in a letter to Giuliano de' Medici that he was suffering from an illness. He did not specify its nature, and no evidence survives to indicate whether or not it was long-lasting or serious. However, the evidence of the letter, which is quite long and deals with other matters, suggests nothing particularly grave. The most obvious malady suffered in Rome in the summer was malaria.

Around this time, Leonardo wrote a cryptic sentence in one of his notebooks: *li medici mi crearono e distrussero*. This sentence could be understood in a number of ways: "The Medici created and destroyed me;" or "The doctors created and destroyed me." The first translation makes an ambiguous reference to the Medici, the family whose members served as *de facto* rulers of the Republic of Florence between 1434 and 1494, and then again after 1512. The second translation suggests a distrust of doctors, possibly related to the 1515 malady. However, his sponsor in October 1515, when he enrolled in a confraternity in Rome, was a doctor named Gaiacqo. The fact that a doctor sponsored him for membership in a confraternity (one of whose services was burying deceased members) could indicate that he was under the care of a doctor at this point, and that the

condition mentioned several months earlier may have been sufficiently serious to make him consider the post-mortem disposition of his bodily remains.

One of Leonardo's notes (Richter, 1970, §1163) laments the onset of age and its infirmities: "O Time! consumer of all things; O envious age! thou dost destroy all things and devour all things with the relentless teeth of years, little by little in a slow death."

Leonardo's Paralysis

In 1517 a visitor to Leonardo's studio in France, a priest named Antonio de Beatis, claimed that the painter's right hand was "somewhat paralyzed," leaving him unable to paint. He wrote that Leonardo could not "colour with such sweetness as he used to" (Beatis, 1979). At the time Leonardo was 65 years of age; he would die two years later. Beatis's claim is curious because all other evidence suggests that Leonardo painted with his left hand, not his right. It may have been that Beatis witnessed Leonardo working with his left hand – an unusual sight in the 16th century when lefthandedness was suppressed. He may therefore have assumed that the painter's right hand was injured. However, Beatis stresses that Leonardo suffered a paralysis, which seems to suggest a stroke. His comment about the loss of "sweetness" possibly suggests a diminution of Leonardo's artistic powers that goes beyond his observation of apparent paralysis.

Beatis claimed that Leonardo was "an old man of over seventy" when in fact the painter was only 65. This overestimation of the painter's age might suggest that Leonardo was indeed debilitated in some way.

Leonardo's Death

Leonardo drew up his will on 23 April 1519 and died nine days later, on 2 May, at the age of 67 years and 17 days. The fact that he died little more than a week after making his will suggests that his death was not unexpected, and Vasari later reported that he had been ill for many months before his death. He appears to have done very little work in the last year of his life, which further indicates a debilitating illness. No cause of death has been given or discovered. The only account of Leonardo's deathbed is the one provided many years later by Vasari, in which Leonardo expires in the arms of King François. However, it has been shown that, as François was at Saint-Germain-en-Laye on 3 May, a 2-day ride from Amboise, he could not have been present for Leonardo's death.

Location of Residences

Vinci, Tuscany: 1452-c.1466 (approximately 14 years)

Florence: c.1466-1482 and 1500-1506 (22 years)

Milan: 1482-1499 and 1506-1513 (24 years)

Rome: 1513-1516 (3 years)

Amboise, France: 1516-1519 (3 years)

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Tracing the Da Vinci Tomb in the Badia Fiorentina

In the late fifteenth century, the father of Leonardo da Vinci, whose origins have fascinated scholars for well over a century, installed a tomb for himself and his descendants in the Florentine monastery known today as the Badia Fiorentina. Leonardo's complex family included four stepmothers and twenty-three half brothers and half sisters and their offspring, many of whom were buried at the Badia. This article traces the history of the Da Vinci tomb from its first burial in 1474 to its last in 1614 to recount which family members were buried therein and when. Since the church was radically renovated in the mid-seventeenth century, this paper also provides evidence for where the tomb chamber was originally located and where its remnants might be found through archeological excavation.

Introduction

In the third quarter of the fifteenth century, the notary Ser Piero d'Antonio di Ser Piero di Ser Guido da Vinci, father of the artist Leonardo da Vinci (Möller, 1939; Villata, 1999; Vecce, 2006; Ulivi, 2008; Ulivi, 2009a),¹ installed a tomb for himself and his kin in the church of Santa Maria di Firenze, familiarly known as the Badia Fiorentina. The monastery still rises over the city block bound by Via Dante Alighieri at the north, Via del Proconsolo at the east, Via della Condotta at the south, and Via dei Magazzini at the west. Between 1474 and 1614, at least twenty-one family members, some blood kin, others by marriage, were buried in Ser Piero's tomb at the Badia. As is well known, Ser Piero did not marry Leonardo's mother, Caterina, who instead married Accattabriga di Piero del Vacca Buti, with whom she had five children: Piera (b. 1453), Maria (b. 1457), Lisabetta (b. 1459), Francesco (1461-87), and Sandra (b. 1463) (Beltrami, 1919; Cianchi, 1953; Brown, 1998; Villata, 1999; Vecce, 2006; Ulivi, 2008; Ulivi, 2009a; Ulivi, 2009b). Ser Piero, on the other hand, would go on to wed four other women between 1452 and 1485: first, Albiera Amadori (Uzielli, 1872; Vecce, 2006; Ulivi, 2009a; Ulivi, 2009b), then, Francesca Lanfredini in 1465 (Uzielli, 1872; Bambach, 2003; Ulivi, 2007; Ulivi, 2009b), followed by Margherita Giulli in 1475 (Uzielli, 1872), and Lucrezia Cortigiani in 1485 (Ulivi, 2009b). While Ser Piero's first wife and infant daughter were buried in the church of San Biagio, also known as Santa Maria Sopra Porta, in the parish where Ser Piero was living at the time of their deaths (Ulivi, 2007), his three successive wives and many of their children, their spouses, and their children were buried along with Ser Piero in the tomb that he had installed at the Badia at some time prior to the burial of Francesca Lanfredini on 21 February 1474 (Cianchi, 1953; Ulivi, 2007). A tomb register compiled in 1614 indicates that the tomb was dated 1474,² suggesting that it was carved

after 25 March, the start of the Florentine New Year. Subsequent *sepoltuari* compiled by Stefano Rosselli, Placido Puccinelli, and Alfredo Cirri repeat this date. Burial records provide evidence of Francesca's interment at the Badia, suggesting that Ser Piero had paid for a plot and then ordered a tombstone after her burial. Gustavo Uzielli published the tomb's date as 1472 based on an eighteenth-century notation found in the so-called Carte Dei kept at the Archivio di Stato, Florence (ASF), which has been repeated by several historians, even though the reference cannot be traced and contradicts the more reliable *sepoltuari* (Uzielli, 1872; Beltrami, 1919; De Scisciolo, 2006; Vecce, 2006).

The coincidence of the death of Ser Piero's second wife, Francesca Lanfredini, and the inscription recorded as adorning Ser Piero's tomb suggests that it was her passing that inspired him to install a family monument at the Badia Fiorentina, though he may have begun to consider installing a tomb there as early as 1467 when he and Francesca were renting houses in the Badia's neighboring parishes of San Firenze and Sant'Apollinare (Ulivi, 2007). Ser Piero had worked for the Benedictines at the Badia from as early as 1451, renting a notarial shop from the monastery since at least 1456 (Bambach, 2003; Ulivi, 2007). A register of burials at the Badia refers to Ser Piero as "nostro notaio" (our notary),³ and though he was not the only notary to perform services for the monks, this appellation suggests a long and familiar relationship between Ser Piero and the Badia. Indeed, Ser Piero spent the majority of his professional and personal lives in the shadow of the monastery where he established his family's memorial.

Unfortunately, no fragments of his tomb marker have yet been recovered, and we know of its appearance only from a tomb register, or *sepoltuario*, compiled by Francesco della Foresta in 1614. Della Foresta tells us that Piero's tomb consisted of a monument, likely a rectangular stone slab measuring about 2.75 meters long and 1.5 meters wide. It included a round marble cover, or *chiusino*, that bore heraldry and an inscription. Della Foresta locates the tomb as "from the door of the choir toward the organ." He describes the coat of arms as carrying alternating vertical bands of gold and red,⁴ perhaps made with bronze and red marble (Uzielli, 1872; Beltrami, 1919). The inscription identified the tomb as belonging to Ser Piero and his descendants: SEP[ULCRUM] S[ER] PIERANTONII S[ER] PETRI DE VINCIO ET SUORUM, ANNO D[OMI]NI 1474. Della Foresta makes clear, both in the Vinci entry and in those of the tombs nearby, that Ser Piero's tomb was at the foot of the choir (Figure 1, no. 22).

The next description of Ser Piero's memorial comes from Stefano Rosselli's *sepoltuario* of 1657,⁵ which he says was based on the aforementioned register by Della Foresta, in his words "diligently compiled" half a century earlier. Rosselli had to rely on Della Foresta because of significant renovations to the Badia's church interior, which had been underway since 1627. Rosselli's description differs from Della Foresta's in one significant point – he only mentions the *chiusino*, suggesting that Ser Piero's marker had been separated from its original monument, preserving only the portion with the arms and inscription.

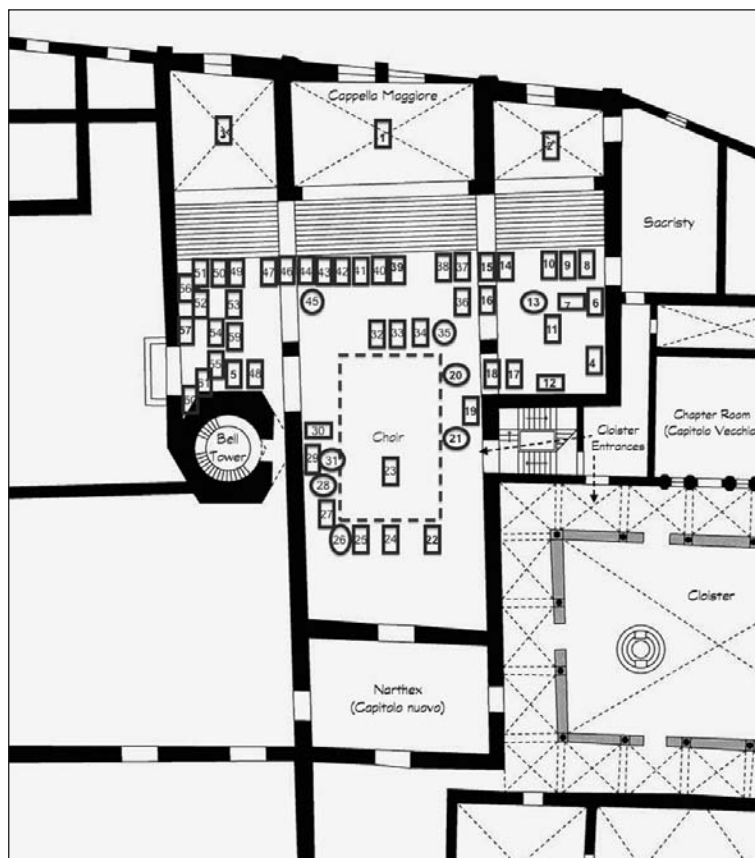


Figure 1. Reconstruction of the Badia Fiorentina prior to 1627, all dimensions and positions are approximate (adapted from Leader, 2012, Fig. 1.7).

The next account of Ser Piero's tomb appeared soon thereafter in a publication of 1664 by Don Placido Puccinelli, a Benedictine monk who served various offices during his career at the Badia from 1626 to 1685 (Puccinelli, 1664). Puccinelli only recorded Ser Piero's inscription. And, he provided a different location for the marker, saying it was in the *capitolo nuovo*, or new chapter room, created during the renovations in the space of the former narthex (Figures 1 & 2) So, rather than at the foot of the choir as stated by Della Foresta and repeated by Rosselli, Puccinelli placed it in the *capitolo nuovo*, though he did not specify where.

Puccinelli compiled his *Memorie sepolcrali* as a means to preserve for posterity the inscriptions from the Badia's tomb markers, which were in danger of disappearing to the

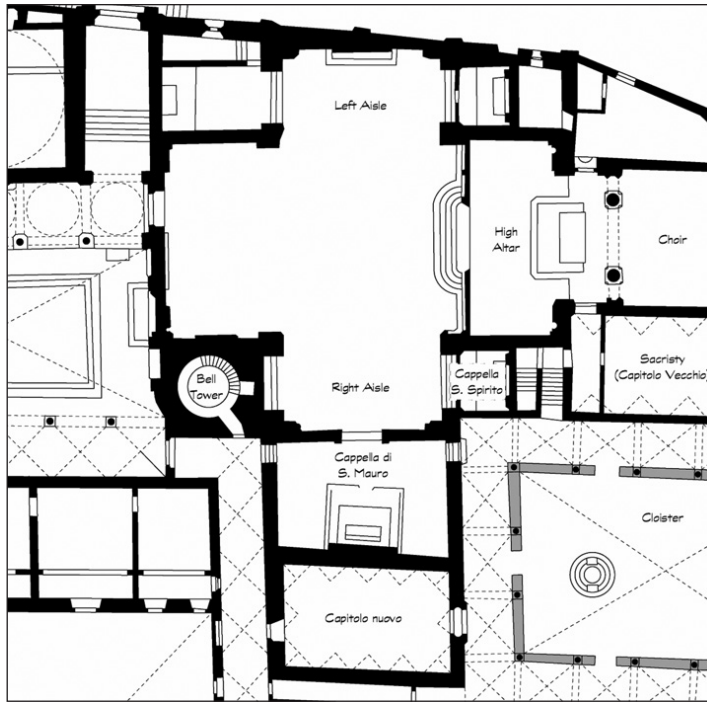


Figure 2. The Badia Fiorentina today (adapted from Leader, 2012, Fig. 1.8).

ravages of time, weather, and dispersal through renovations of the monastic complex, especially the repaving of the new church interior in 1663. Unlike the majority of entries that include an illustration and transcription, Puccinelli only recorded the inscription from Ser Piero's marker, raising the possibility that its coat of arms had suffered significant damage or was no longer extant by 1664 (Puccinelli does not give an explanation as to why some of his records include coats of arms and others do not).

Even though Puccinelli locates Ser Piero's tomb marker in the *capitolo nuovo*, given the earlier accounts of its placement at the foot of the church choir, it seems that Ser Piero's marker was moved during renovations in the mid-seventeenth century. Whether Ser Piero's remains, and those of his relatives, were also translated is unclear, though it seems likely that any bones would have been left alone in the original grave pit with only the decorative cover transferred to a new location. A hitherto unknown necrology records burials at the Badia from the early sixteenth through the mid-eighteenth centuries, noting the interment of various members of Ser Piero's family between 1504 (Ser Piero himself) and 1614 (Giovanni di Piero di Guglielmo, Ser Piero's great-grandson), all of whom were buried at the foot of the choir in the tomb's original location.

The Badia's necrology records how in 1663 the church floor (described as cracked, damaged, and ruined) was demolished, with all tomb markers moved to the walls and

pavement of the cloister.⁶ An eighteenth-century note states that Ser Piero's tomb cover was installed in the western wall of the cloister, where a number of fragments remain today. When historian Gustavo Uzielli visited the Badia in the late nineteenth century to confirm this report, he found no trace of Ser Piero's tomb (Uzielli, 1872). The repaved church floor included gravesites for displaced families at a cost of fourteen *scudi* per plot. Thus, the *capitolo nuovo* tomb described by Puccinelli may have been one such new grave, installed for the Da Vinci family in the *capitolo nuovo* after 1663 but never used for burial; their last interment was in 1614 upon the death of Ser Piero's great-grandson, Giovanni.

Despite the serious changes to the Badia between Ser Piero's day and our own, there is nevertheless good reason to believe that remnants of his tomb chamber still exist under the floor of the Badia's church. Locating Ser Piero's original gravesite, however, is made difficult by the fact that it lies under a church interior that was significantly remodeled between 1627 and 1664, the third rebuilding of the monastic church over its long history. Any study of the ground underneath the current pavement must keep in mind the successive building campaigns of the tenth, fourteenth, and seventeenth centuries, each of which raised the floor level of the church, not to mention the numerous burials that took place from at least the mid-thirteenth century through to the late eighteenth century. The third and final renovation of the Badia's church gutted its interior, destroying the medieval choir and presbytery, rotating the church orientation by ninety degrees, and leveling as well as repaving the floor in 1663, when older tomb markers were transferred to other locations in the monastic compound. The renovations also saw the western end of the nave converted into a chapel dedicated to San Mauro, an area that likely once held tombs and possibly the entrance to the choir. The church pavement was replaced again in the mid-twentieth century after the great flood of 1966 (Puccinelli, 1664; Guidotti, 1982).

As previously explained, our knowledge of the original topography of tombs at the Badia comes primarily from two sources: Della Foresta's previously discussed *sepoltuario*, and a manuscript necrology that records burials at the Badia from 1499 through to the middle of the eighteenth century. While these two sources are indispensable to reconstruct the original layout of the Badia's commemorative monuments, they were written by and for people familiar with the church and thus are not always as clear as we would like in their descriptions. Though the *sepoltuario* by Della Foresta is somewhat well known to scholars, the necrology manuscript has been overlooked as a source of information about the original layout of the Badia's interior and the burials therein. It is now kept at the Biblioteca Nazionale Centrale di Firenze in the collection of books under the rubric *Conventi Soppressi da Ordinare*. These two manuscripts, when compared to earlier descriptions of the Badia's interior, allow us with a fair amount of certainty to locate the approximate area in which Ser Piero installed his family's monument.

Typical of property inventories and church tomb records, Della Foresta's registry is written according to placement, as if the antiquarian were walking around the church, pointing out monuments as he moved. While he most likely referred to and copied lists of tombs kept by the monks, rather than taking field notes himself, his *sepoltuario* can be

reconstructed with some precision and mapped on a floor plan of the building. Churches typically kept such topographic records to keep track of who was buried where in their churches, as they were required to say masses for the dead as well as sell tomb plots to new patrons when lineages died out and could no longer support a family gravesite.

Since we know neither the original dimensions nor the distances from one tomb to another at the Badia, without additional archaeological evidence, it is difficult to say precisely where each marker once lay, and only one monument – that of Giannozzo Pandolfini (Figure 1, no. 57) – remains in its original location. Nevertheless, we can locate the general vicinity of each tomb with respect to its neighbors by following Della Foresta's description. The aforementioned necrology corroborates this reconstruction as it frequently gives spatial locators for individual tombs, which, taken together and compared with Della Foresta, confirm the locations of individual monuments within the Benedictine compound. The necrology is organized by date of burial and is further indexed by family name. Like Puccinelli's *Memorie sepolcrali*, it cannot be read as the topography of the Badia's burial grounds but can nevertheless corroborate the hypothetical tomb-scape suggested by Della Foresta's *sepoltuario*.⁷

Della Foresta recorded that Ser Piero's tomb was near the entrance to the choir. While we know neither the precise location nor the size of the choir, we can assume that it was in the nave close by the entrance to the cloister, from which the monks would enter the enclosed space multiple times per day (though Figure 1 places the choir in the center of the fourteenth-century nave, it may have sat several meters closer to the high altar at the east, or, alternatively, several meters closer to the narthex at the west in the area now occupied by the San Mauro chapel). Both the Badia's necrology and Della Foresta regularly use the choir to locate tombs that flanked its enclosure wall, including those belonging to the Acciaiuoli (Figure 1, no. 21), Valori (no. 23, at the center of the choir), Carlini (no. 24), Leopardi (no. 25), and Dalle Fonte (no. 26) families, as well as that of Da Vinci (no. 22). A mid-fourteenth-century description of the six altars present in the Badia describes two lateral altars as on either side of the choir,⁸ thus helping to place it in the nave in the area bound by the narthex at the west and a pair of freestanding piers towards the east that carried the arches that divided the aisles from the nave (Leader, 2012).

We can further specify the location of Ser Piero's tomb through Della Foresta's description that it was on the same side of the church as the organ, which we know was at the end of the southern aisle, close to the cloister entrance in the adjacent nave (Guidotti, 1982; Leader, 2012). Della Foresta further stipulated that Ser Piero's tomb was near those belonging to the Acciaiuoli (Figure 1, no. 21) and Carlini families (no. 24), which he also described as bordering the choir.⁹ This reconstruction is confirmed by the Badia's necrology, which specifies that Ser Piero's tomb was at the foot of the choir (*a pie del coro*), next to its entrance gate (*al lato al cancello del coro*), on its right hand side (*da man' destra*), and nearby the tomb of the Carlini family.¹⁰ The burial records describe the Carlini family tomb (Figure 1, no. 24) as in front of the choir's entrance, in line with the central axis of the church.¹¹

Even though the precise location of the monks' choir is difficult to determine, based on the descriptions of tombs placed along its balustrade, we can confidently place the choir in the center-west portion of the church (Leader, 2012), with its entrance somewhere in the area that today comprises the San Mauro chapel and the right aisle between the campanile and the Santo Spirito chapel, which fills the space that formerly contained the stairs and entrance to the cloister. Who was buried in Ser Piero's tomb? Records indicate that at least twenty-one family members were interred at the Badia. From the burial of Ser Piero's second wife, Francesca di Ser Giuliano Lanfredini, in February 1474, to his great-grandson, Giovanni, in 1614,¹² an additional two wives, six sons, three daughters, three grandchildren, and four in-laws were buried in the Badia Fiorentina with Ser Piero, twenty-one corpses in all (Table 1).

Name	Relationship	Birth	Death
1. Francesca Lanfredini	stepmother	1449	1474
2. Maddalena di S. Piero	half-sister	1477	1477
3. Margherita Giulli	stepmother	1457	1485
4. Bartolomeo di S. Piero	half-brother	1485	1485
5. Guglielmo Francesco di S. Piero	half-brother	1486	1486
6. Girl di S. Piero	half-sister	1490 ca.	1490
7. Piero di Antonio	father	1426	1504
8. Lucrezia di S. Piero	half-sister	1504 ca.	1505
9. Pierfilippo di S. Piero	half-brother		1516
10. Giuliano di S. Piero	half-brother	1478	1525
11. Benedetto di S. Piero	half-brother	1489	1531
12. Lucrezia Cortigiani	stepmother	1459	1531
13. Lorenzo di S. Piero	half-brother	1480	1544
14. Clemenza di Guglielmo	half-niece		1565
15. Margherita	in-law		1569
16. Piero di Guglielmo	half-nephew		1575
17. Francesco di Lodovico Ruggieri	in-law		1579
18. Marietta Buonaccorsi	in-law	1504 ca.	1584
19. Violante di S. Giuliano	half-niece	1517	1589
20. Lisabetta Cantucci	in-law		1599
21. Giovanni di Piero	half-great-nephew		1614

Table 1. Relatives of Leonardo di S. Piero da Vinci in chronological order of burial at the Badia.

To review: based on what is known about the configuration of the original medieval church, the choir entrance was somewhere in the area now contained by the right aisle, between the campanile and the current Santo Spirito chapel, and the chapel of San Mauro, which was built out of the western end of the medieval church nave in the seventeenth century. Ser Piero's tomb was installed in the medieval pavement at or near the southwest corner of the choir, between its presumed central access point, where the Carlini would install their monument, and the choir's southern balustrade. This floor and the tomb markers inserted therein were demolished in the mid seventeenth century to make way for new tomb plots and a new floor, likely installed at a higher level than the original church floor. Unfortunately, without any known dimensions for the choir or the individual tombs that surrounded it, it is difficult to be more precise regarding the location of Ser Piero's monument (Figure 3).

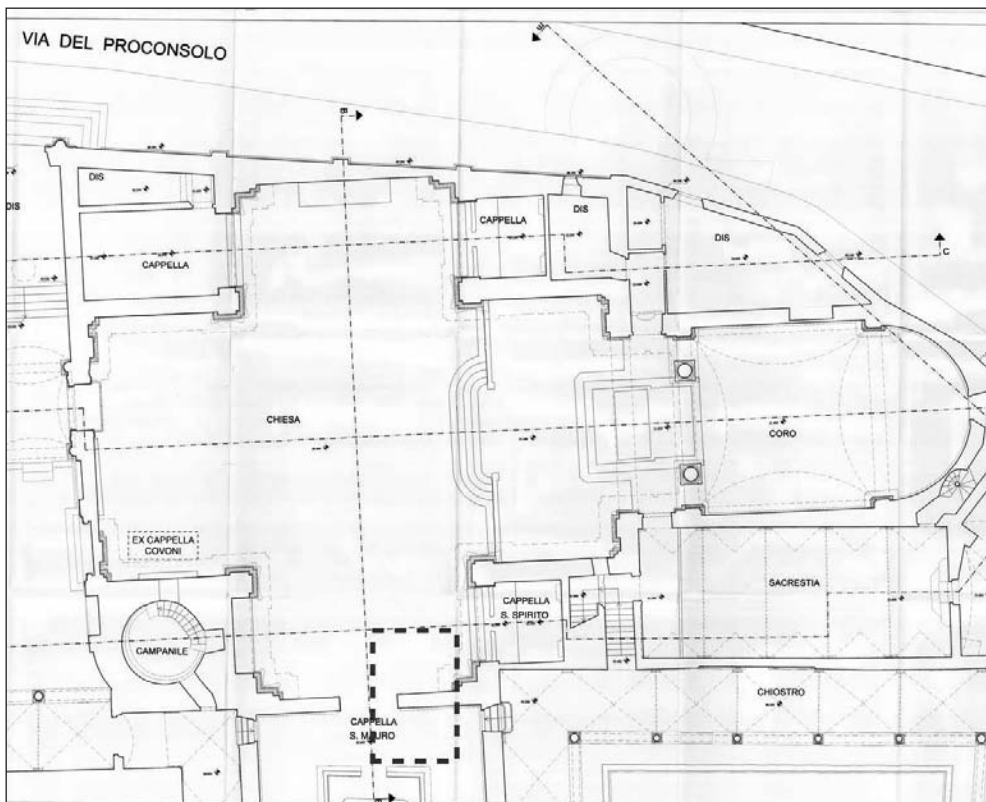


Figure 3. The Badia as it appears today, area to excavate outlined in dashed lines.

Nevertheless, excavations in the southwest corner of the right aisle and the southeast corner of the San Mauro chapel should bear fruit in the search for Ser Piero's tomb.

Endnotes

- 1 Budd (2005) has raised the possibility that Ser Piero's younger brother, Francesco di Antonio, was the father of Leonardo. Though historians have not accepted this hypothesis, geneticists should keep it in mind.
- 2 Archivio di Stato di Firenze (hereafter ASF), *Manoscritti*, 628, fol. 5, no. 22.
- 3 Biblioteca Nazionale di Firenze (hereafter BNF), Conventi Soppressi da Ordinare, Badia, 2 (*str.* 1): *Libro nel quale sono registrati tutti i defunti...1499-1712* (hereafter Libro dei Defunti), fol. 3r.
- 4 ASF, *Manoscritti*, 628, fol. 5, no. 22.
- 5 ASF, *Manoscritti*, vol. 624, p. 610, no. 23.
- 6 BNF, Libro dei defunti, fol. 87.
- 7 ASF, *Manoscritti* 628, fol. 5, no. 22; ASF, *Manoscritti*, 624, p. 610, no. 23.
- 8 ASF, *Diplomatico, Normali*, Firenze, S. Maria della Badia detta Badia Fiorentina, 14 July 1453.
- 9 ASF, *Man.* 628, fols. 4v-5v, nos. 21-24.
- 10 BNF, Libro dei Defunti, fols. 3, 6, 10, 14v, 18, 28, 29, 33v, 39, 42v, 59, and 69.
- 11 ASF, *Man.* 628, fol. 5v; BNF, Libro Defunti, fol. 38, 39, 72.
- 12 BNF, Libro dei Defunti, fol. 69r; ASF, Medici Speciali, 256, fol. 161v; ASF, *Grascia*, 194, fol. 233.

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KEY WORDS: *Ground-penetrating radar (GPR), Badia Fiorentina, geophysical prospection, Da Vinci family tomb.*

A Ground Penetrating Radar (GPR) Survey of the Florentine Abbey – the Badia Fiorentina (Italy) – as Part of the Search for the Family Tomb of Leonardo da Vinci

Ground Penetrating Radar (GPR) is one of the most frequently used methods for investigating the first section below ground, and is therefore considered a vital tool for archaeological investigations and studies. The purpose of the GPR survey carried out at the Badia Fiorentina, where historical documents indicate the presence of the family tomb of Leonardo da Vinci, was to identify electromagnetic anomalies indicative of tombs.

GPR data acquisition was carried out in two areas of the abbey: one in correspondence with the central and lateral aisles; and the other inside the chapel of St. Mauro. A mono-static GPR system, RIS_MF_HiMod (I.D.S. S.p.A), was used with a dual frequency antenna (200-600 MHz). After completing the survey, the data was processed and noise components were effectively removed.

Through our interpretation of the data it transpired that there were several areas with electromagnetic anomalies considered to be of interest for further archaeological investigations – five in the main portion of the abbey and three in the chapel of St. Mauro.

The aims of the survey

Historical sources indicate that in the third quarter of the fifteenth century the notary Ser Piero di Antonio, father of Leonardo da Vinci, installed a tomb for himself and his family in the church of Santa Maria di Firenze, otherwise known as the Badia Fiorentina (Leader, 2014; see also Leader, 2012).

Geophysical prospecting is an integral part of archaeological studies to individuate anomalies caused by man-made vacuums (tombs). For this reason, an investigation was carried out in the Badia Fiorentina with Ground Penetrating Radar (GPR), a method that is generally applied in archaeological surveys (Goodman & Nishimura, 1993; Vaughan, 1986), and in this case a dual frequency antenna (200 e 600 MHz) was used.

Data acquisition took place on 16 February 2015 and data processing and interpretation were performed by personnel from the Laboratory of Geophysics and Applied Geophysics at the Centro di GeoTecnologie, which is part of the University of Siena.

The GPR method

GPR is radar equipment used for non-invasive investigations of the ground, structures and artifacts (Conyers, 2004; Daniels, 2004).

GPR uses electromagnetic waves consisting of a combination of continuous and simultaneous vibrations of the electric and magnetic fields. The propagation velocity of an electromagnetic wave is a function of the magnetic and dielectric properties of the material through which the wave travels. Some materials allow better penetration of the wave than others, like water or shale that attenuate the signal (Conyers, 2004). At the same time, the depth that radar energy can penetrate and the degree of definition of the signals are also a function of the frequency of the wave energy transmitted. With high frequency waves, there is less penetration but greater resolution, while with low frequency waves the penetration is greater but with a lower grade of resolution.

The main features of the GPR operating system are shown in Figure 1. The control unit generates a trigger impulse transmitted via a transducer cable. In the transducer cable, each trigger impulse is transformed into a bipolar impulse and increased in amplitude (the electric signal becomes an electromagnetic wave). The impulse is then conveyed by the transmitter antenna below ground where contrasts in dielectric properties generate observable reflections. The receiver antenna intercepts the return signal and sends it to the control unit, which processes it, and it is displayed in real time on the PC.

Each trace is recorded in the form of an oscillogram (A-Scan) and the intensity of the reflection is determined by the amplitude of the oscillogram, expressed in mV/ns (Daniels, 2004).

A GPR section is created by plotting the traces side by side, producing a record in which the horizontal axis represents distance and the vertical axis two-way reflection time (Milson, 2003) or, in metric units, the depth of the signal transmitted.

Buried targets are not displayed in their real shapes, but as hyperbolic forms. In fact, the transmitter antenna radiates electromagnetic waves into the ground, which penetrate the undersurface in the form of a “cone,” widening with depth. Hence, because of conical transmission, targets are intercepted not only when the antenna is directly above them, but also when it is positioned either just before or after them (Milson, 2003).

Operating decisions and data processing

Data acquisition was carried out in two main areas of the abbey; the first in correspondence with the central and lateral aisles, and the second inside the chapel of St. Mauro (Figure 2).

This survey was carried out with the application of acquisition grids (the smallest spacing used in the grids was 0.5 m, to allow full coverage of the area with GPR); the grid for the area corresponding to the central and lateral aisles was composed of 26 transversal lines (TID) and 46 longitudinal lines (LID), for a total of 72 lines. Whereas

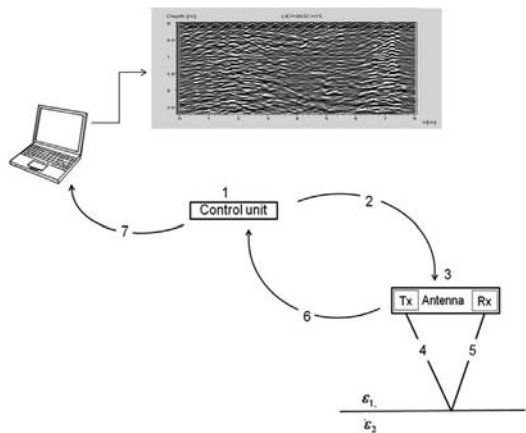


Figure 1. GPR operating system.

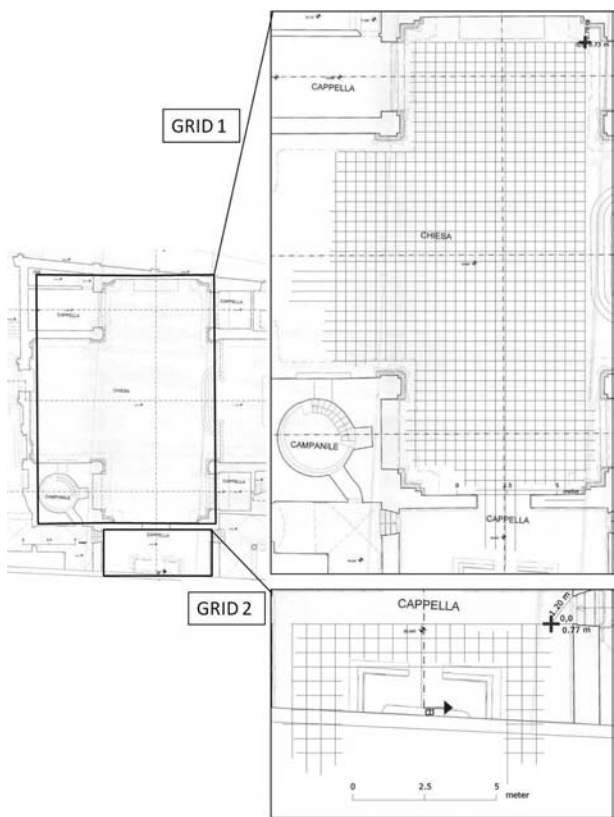


Figure 2. Locations within the abbey for which the two grids were devised. The first, in correspondence with the central and lateral aisles, and the second, the chapel of St. Mauro.

the grid corresponding to the chapel of St. Mauro was composed of 18 transversal lines and 16 longitudinal lines, for a total of 34 lines.

The acquired raw data first had to be processed before it could be interpreted. In order to do this, dedicated software, GRED V. 2.01.015, was used and the following processes were applied to each trace:

- moving start time, to align the depth scale of the radar map to the surface investigated;
- background removal, to remove the continuous component along the x direction;
- vertical band pass filtering (TD), to filter noise components along the y direction;
- linear gain, to equalize the acquired signal in function of the linear attenuation;
- smoothed gain, to equalize the signal power in accordance with a time varying window. This applied a time-varying gain to each trace individually, with the gain calculated so as to keep the average absolute amplitude constant within a window that slides down the trace (Bacon et al., 2007).

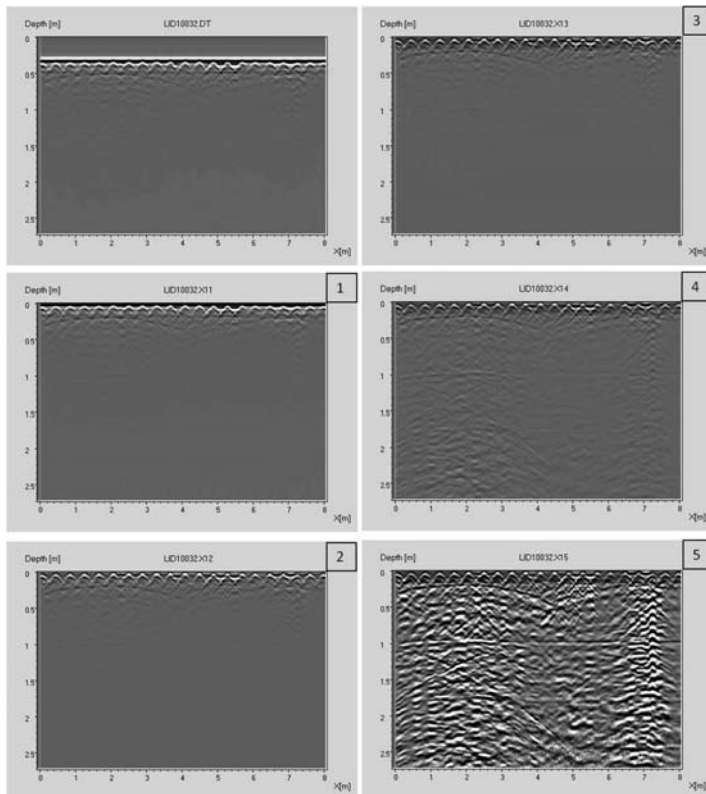


Figure 3. This shows how each processing operation effected the raw data. No. 1 after moving start time, no. 2 after background removal, no. 3 after the application of vertical band pass filtering, no. 4 after linear gain, and no. 5 after smoothed gain.

Results from the first grid corresponding to the central and lateral aisles of the abbey

From observations of the collected (B-Scan, C-Scan and 3D) data we identified five areas with different types of reflections, which have been delineated and marked with numbers (see Figure 6).

Area 1: an area of about 8.5 m x 3 m, characterized by hyperbolic reflections of notable amplitude, circa 0.40 m to circa 1 m from the surface, with the presence of a horizontal reflection (Figure 4). This form was interpreted as perhaps an architectonic element with arches (for similar studies see Zanzi & Lualdi, 2008).

Area 2: an area of about 4.7 m x 2.1 m, characterized by typical reflections of heterogeneous material, with some horizontal signals inside small lateral extensions. These were registered at different depths; from circa 0.70 m and 0.80 m from the surface to circa 2 m. Their shape, on the scans, can be identified as repeated targets of rectangular shape, circa 0.7 m in length, at intervals of circa 0.5 m one from the other (Figure 5). These were interpreted possibly as empty spaces separated by walls of indefinable material (for similar studies see Baldi, Campana, Durante, & Felici, 2004).

Area 3: an area of about 7 m x 3 m, characterized by reflections at a depth of circa 0.7 m from the surface and with small lateral extensions of circa 0.7 m that were repeated every 0.3 - 0.4 m. These reflections were observed up to a depth of circa 2 m. This target was interpreted possibly as elements of stonework each separated from the other; this complex in its underlying geometry could be attributed to empty chambers (for similar studies see Campana, Durante, & Felici, 2004).

Area 4: an area of about 8.5 m x 3.5 m, this area was characterized by three single reflections at circa 0.40 m from the surface. These reflections were recorded in three different zones and were visible up to 1.5 m from the surface. When observing the B-Scan, these targets could be seen from the start of the longitudinal scans up to 1 m, then from 3.8 m to 5 m, and from 7.5 m to the end of the scans. These targets seem to be rectangular in shape, open at one end, and divided into two parts by some sort of structure. These targets were interpreted either as a structure divided into chambers or architectonic elements of the previous church.

Area 5: an area of about 2.5 m x 9.5 m, characterized by reflections with small lateral extensions at different depths, one circa 1.1 m from the surface and the other at shallower alternate levels circa 0.40 m from the surface. These targets were interpreted as possibly elements of the foundations or architectonic elements of the previous church.

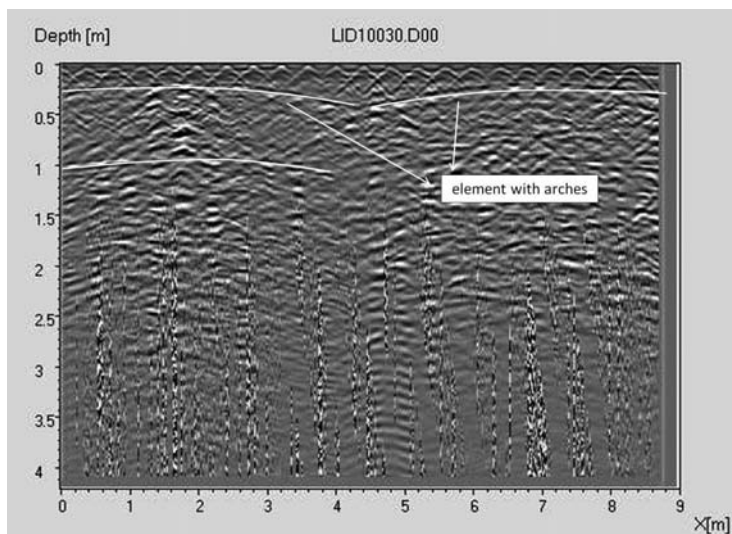


Figure 4. B-Scan LID10030. Scan of Area 1 corresponding to the lateral aisle of the abbey. The white lines indicate reflections in the shape of arches.

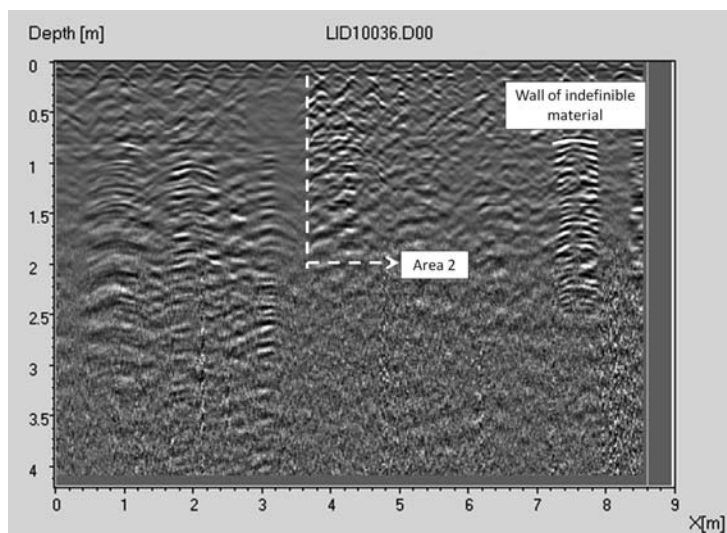


Figure 5. B-Scan LID10036. Scan of Area 2, corresponding to the central and lateral aisles of the abbey. The broken white line indicates the boundaries of Area 2, while the shorter continuous white line indicates the reflections. The reflections in this area were interpreted as perhaps compartments separated by rectangular structures.

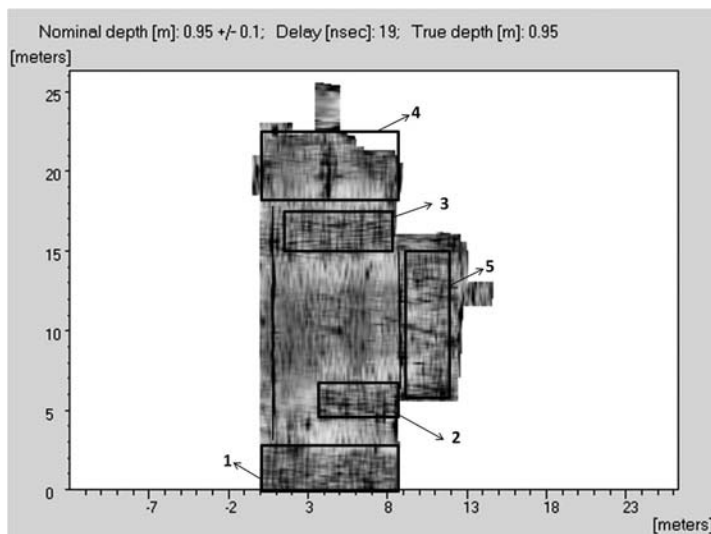


Figure 6. C-Scan (elaboration of the two directions acquired with a 600 MHz antenna, a slice at 0.95 m from the surface). The numbers indicate the different areas previously described: Area 1, with reflections thought to represent an architectonic element with arches; Area 2 and Area 3, possibly indicating compartments composed of empty spaces separated by structures of indefinable material; Area 4, perhaps either a structure divided into compartments or elements of the previous church; and Area 5, with targets thought to represent remains of the abbey's original foundations or elements of the previous church.

Results from the second grid corresponding to the chapel of St Mauro

From observations of the B-Scan, C-Scan and 3D data acquired from the Chapel of St Mauro, three areas were identified with different types of reflections, which were delineated and marked with numbers (see Figure 7).

Area 1: an area of about 1 m x 1.5 m, characterized by horizontal and hyperbolic reflections at different depths of 0.4 m, 0.5 m and 1.2 m from the surface. These reflections were visible below a marble slab in the abbey's floor. These targets were interpreted as likely compartments with empty spaces separated by a structure of indefinable material.

Area 2: an area of about 5.4 m x 1.5 m, characterized by reflections with significant lateral extensions, circa 0.9 m from the surface. Another type of reflection was visible 2.5 m from the surface. Considering that this area bordered on Area 4 in the main part of the abbey (Figure 8), these reflections were likewise interpreted as possibly being a structure divided into compartments or the remains of the previous church.

Area 3: an area of about 1 m x 4.5 m, characterized by two types of reflections. The first was visible at circa 0.1 m from the surface, the second was localized circa 1 m from the surface. In the C-Scan, another reflection could be seen over 1.6 m from the surface. These targets were interpreted as compartments divided by structures of indefinable material (Figure 7).

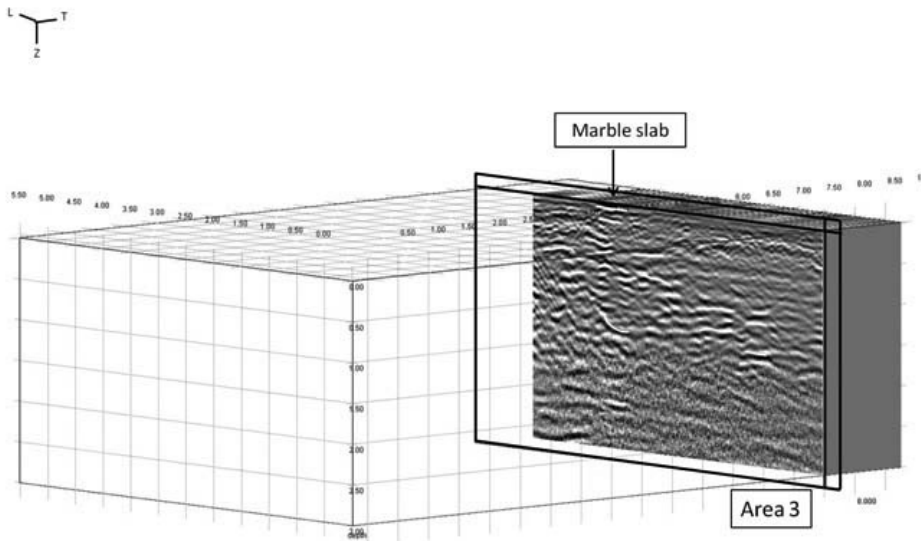


Figure 7. 3D image of a slice at 8 m from the start of the cross scans. The area outlined, Area 3 in the Chapel of St Mauro, shows reflections interpreted as compartments divided by structures of indefinable material.

Conclusions

In conclusion, despite the complexity of operating in an environment that has been intensely modified by human interventions over many centuries, radar signals relative to electromagnetic anomalies indicative of tombs have hereby been reported and discussed. With reference to these anomalies, we recommend that future investigations pay particular attention to areas where reflections show regular geometric alignments, described as compartments divided by structures of indefinable material. GPR does not allow one to determine the type of material observed. Hence, in our view, the areas with electromagnetic anomalies most likely to be consistent with tombs are Areas 2 and 3 in the grid corresponding to the lateral and central aisles of the main part of the abbey (Figure 8), and Areas 1 and 3 in the grid corresponding to the chapel of St. Mauro (see Figure 9).

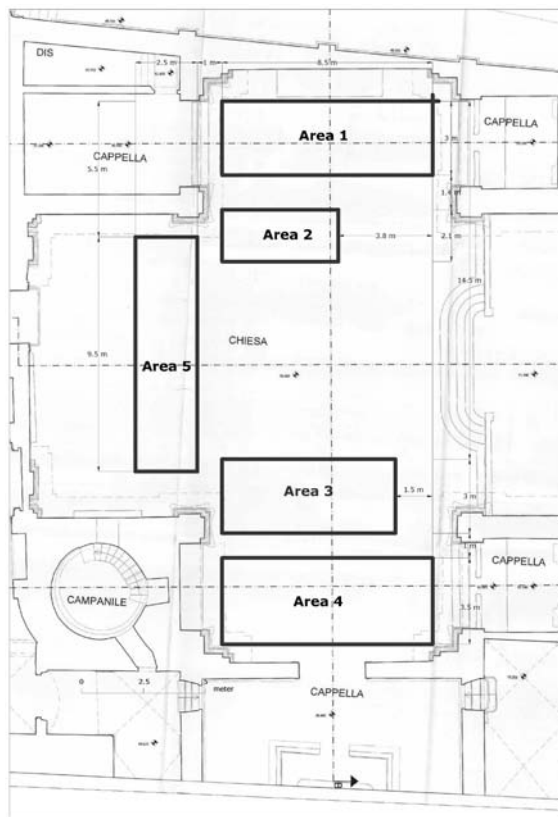


Figure 8. Areas in the main part of the abbey where key targets were identified with GPR.

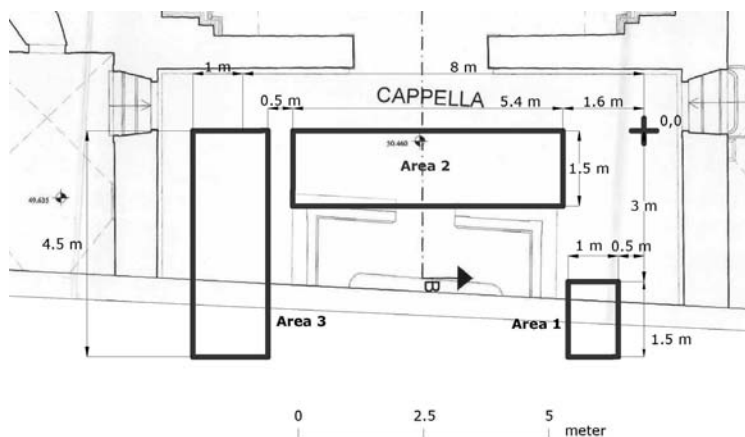


Figure 9. Areas in the chapel of St Mauro where key targets were identified.

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Leonardo Da Vinci and his Family from the 14th Century until the Present-Day

This research, still in progress, began in theory in 1969 and in practice in 1973, with a global investigation and the cross-checking of discoveries and heterogeneous interdisciplinary data. The theme is one that is vast and has already been extensively explored, though not sufficiently so, namely, the history of the family of Leonardo Da Vinci, and the places he frequented during his lifetime, including also his origins, his paternal grandmother from Bacchereto, his mother Caterina, and other family members hitherto unknown. During the course of this work, new information has come to light concerning areas beyond Italy and France, as far away as Valencia and Majorca.

Sometimes, discoveries have been kept secret pending advances in research and the right moment for their publication.

Since the 1980s, this investigation also aimed to identify still living direct descendants of Ser Piero, Leonardo's father. In fact, from 2006 onwards, we have progressively and successfully verified the continuity of descent, in the direct male line, of one of Leonardo's brothers, Domenico Matteo, right down to our own time, and also identified many 20th-century graves. As with the attribution of works of art, so too with historical research does Museo Ideale Leonardo Da Vinci proceed with extreme caution and absolute discretion, making known discoveries, trying to resolve as yet unanswered questions and problems, and identifying lines of investigation still to be followed – carefully distinguishing the assumptions and misunderstandings of the media from hypotheses and reasonable certainties. Publications of this nature serve, among other things, to stimulate communication between scholars, or even from the descendants themselves, and to evaluate and safeguard historic sites such as houses and burial places.

While there remain a great many leads to be investigated by historians, for biologists and anthropologists this research yields certain data from which to work, providing the possibility to identify, through DNA analysis, the remains of Leonardo and compare them to DNA samples obtained from living descendants.

KEY WORDS: *Leonardo Da Vinci, Grandfather Antonio, Fruosino di Ser Giovanni, Caterina, Domenico Matteo, genealogy, burials, Orbignano, Bacchereto, San Pantaleo, living descendants, fingerprints, DNA.*

Foreword

Here we present a synopsis of the results of extremely complex research that is still in progress so as to introduce with a series of examples our contribution to the Leonardo Project. This study of the family of Leonardo Da Vinci entered its preliminary stage forty-seven years ago,¹ and has continued until today as a wide-ranging investigation now allowing us to present with certainty, after twelve generations and up to the fifteenth, the living descendants of a direct male line originating from Ser Piero and his son Domenico Matteo.

These historical and familial data are now at the disposal of the most innovative researchers in anthropology and biology.

Our initial point of reference was *Vinci, Leonardo e la sua Famiglia* published in 1953 by Renzo Cianchi,² and it was he who first introduced me to the study of the fundamental texts and collections on this subject, from Gustavo Uzielli to Giovan Battista Dei, a study that I have continued and amplified, making use of all possible sources.

Contributions to this research also came from those, in the 1970s, who interacted with the conceptual neo-avantgarde, operating with memory, and anthropological, philological and creative approaches.

Our investigations have not been limited to the State, Diocesan and Episcopal, Municipal and Parochial Archives, nor to various libraries, but have extended into the field, to churches and cemeteries, to forgotten places, to the possessions and possible burial places of Leonardo's family (his at least twenty-one, or possibly twenty-four, brothers and sisters, and therefore innumerable descendants).

We have concentrated not only on biographical and archival documents (cadastral returns; records of baptisms, marriages and deaths; parish registers; censuses; contracts; wills, etc.), but our work has also comprised interviews, lectures and commemorations, oral and written local traditions (including legends), public and private correspondence, manuscripts (including study notes and reference notes), toponymy, historical maps, old photographs, innumerable books on Leonardo and on local history, pamphlets,³ newspaper cuttings, and exhibitions, including a study of the dwellings of the Da Vincis and of the Vincis, inspections of building restorations, and renaissance and modern archaeological excavations – in Vinci and in many other towns, cities, and countries.

As with the other activities of Museo Ideale Leonardo Da Vinci, the investigative methodology has always been that of gathering and cross-checking published and unpublished data from widely varied sources, formulating hypotheses, and developing new lines of research, thereby arriving at other studies and discoveries, while awaiting the confirmation of data and further results.

Our objective was not simply to revise and update the Da Vinci family tree, but also to identify those Vinci-related places that should be recognized, enhanced and safeguarded, thereby rediscovering the original context and recomposing a complex mosaic for the lasting benefit of art historians and scholars.

A living family tree

In the different phases of our work, we have followed a twofold chronological criterion: proceeding first from the historical origins determined by various scholars, and from the Da Vinci family papers and additional documents discovered by ourselves, in other words, starting from the earliest ancestors (and from their first descendants, including Leonardo's father) and continuing down to the present-day; and second, working backwards from the most recent traces (identified in our own time) to the earliest ones, so as to ascertain the connections. Our research, therefore, has been centrifugal and centripetal, diachronic and synchronic.

In 1969 it was reported that Leonardo's family had died out or were no longer to be found, as though his genius had become extinct. But then I came across various clues, some scholarly but misleading, some fragmentary or apparently legendary, but others did indeed confirm the existence of living descendants.

Historical family tree

The Da Vinci family tree is based on that conserved by the heirs of Domenico Matteo (Leonardo's brother), drawn up by Dei in 1746; it remained almost unaltered and without significant additions from 1900 to 2008, when it was updated thanks to the extraordinary work of Elisabetta Ulivi,⁴ and to the version that we included in the volume *Leonardo Infinito*, with the addition of the Zoso and the Buti branches, but not yet with the descendants of the Da Vinci from the latter half of the 16th century.⁵

The reconstruction of the Da Vinci family's origins has been complicated by several factors: research that is still incomplete and often fraught with misunderstandings because of the existence of people called "da Vinci" simply because they lived in, or originated from, the town of Vinci.⁶ Confusion may have been engendered by the notaries Ser Rinieri di Salvi da Vinci, in the late 13th century, and by Ser Lippo di Ser Cambio da Vinci, in the first half of the 14th century.⁷

Crollalanza, for example, indicated as "*Vinci (da) di Firenze*" a family that seems not to belong to that of Leonardo, yet in it he included Ser Piero di Ser Guido di Ser Michele Da Vinci, "great-grandfather" of the celebrated artist.⁸ He described their coat of arms as "*d'azzurro, al palo d'oro, accostato da due stelle dello stesso*" (azure, a golden pole, flanked by two stars of the same),⁹ whereas the Da Vinci coat of arms was composed of four golden (or yellow) pallets and three of gules. Cirri, on the other hand, in the *Blasonario Fiorentino* attributed to Leonardo Da Vinci a coat of arms with three golden pallets on an azure field.¹⁰

Other families of the same name were, for example, the Da Vinci family of Pisa, the Vinci family of Messina and of Calabria, and the Vinci family of Fermo, which included Pier Marino di Giovanni, who in 1428 "*era stato eletto podestà di Firenze, ma non vi*

andò” (was elected Podestà of Florence, but did not go) and Concetto di Bonfrancesco “captain in the service of the Duke of Tuscany, Cosimo de’ Medici, who in 1540 made him general superintendent of the city’s fortifications and those of the State of Florence”¹¹... etc.

There is a fundamental distinction between the “Da Vinci” and the “da Vinci” (from Vinci) which we resort to whenever possible for practical reasons: in effect, Leonardo’s family long conserved what had become a surname; the ancestors and brothers of Leonardo and their descendants, even though born in Florence, kept it, contrary to other people and families originating from Vinci.¹²

Another important factor was that the surname “Da Vinci” was simplified to “Vinci.” Ser Anton (or Antonio) Giuseppe Da Vinci was possibly the last, among the descendants of Domenico Matteo, to bear the name in full, at a time when the shortened form, “Vinci,” had long been in use.

A recent study¹³ noted the presence of Vinci families in no fewer than 860 Comunes in Italy, whereas according to online statistics only seven Da Vinci families came to light (three in Apulia, two in Latium, one in Tuscany, and one in Calabria); some have even spread overseas to Connecticut.

We have not neglected to investigate numerous other traces: in a 19th-century engraving by Carlo Biondi, published in Naples by Nicola Gervasi, was portrayed “*Leonardo Vinci celebre maestro di cappella. Nacque in Napoli nel 1690. Ove morì nel 1732*” (Leonardo Vinci, famous choirmaster, born in Naples in 1690, where he died in 1732).¹⁴ Hypotheses were put forward regarding his relationship with the Neapolitan branch of Piero di Piero di Guglielmo Da Vinci, Leonardo’s brother. It would seem, however, that he was born in Strongoli, Calabria, between 1690 and 1696 and that he only died in Naples in 1730. Already in 1872, Uzielli wrote in his chapter *Leonardo da Vinci e sua Famiglia*, that this man was born in Calabria in 1690, and he asked: “Does he belong to the family of Leonardo?” with regard to Piero Da Vinci, great-nephew of Leonardo who “*aveva preso dimora in Napoli*” (had settled in Naples).¹⁵

Of somewhat less importance was another musician, Piero Vinci (Nicosia, c. 1540-1584), who was choirmaster in the church of Santa Maria Maggiore in Bergamo from 1568 to 1580.

The Da Vinci family papers

Plots and intrigues to recover the Da Vinci family papers have also been revealed, featuring rivalry and jealousy. Among those involved were: Lodovico Antonio David, Conte Carlo Rezzonico and his nephew the Marchese Marco Cigalini, Giovanni Ambrogio Mazenta, Giovan Battista Dei, Carlo Amoretti, Giovanni Gaye, Venanzio de Pagave, Anton Francesco Durazzini, Baldassare Oltrocchi, Pietro Cighera, Girolamo Tiraboschi, Bindo Nero Maria Peruzzi, Monsignor Luigi Bottari, Luigi Crespi, Giuseppe Bossi,

Gaetano Milanesi – some of whom made contact with Ser Anton Giuseppe Da Vinci (1726-1803)¹⁶ or with his descendants in Vinci and latterly in Montespertoli.¹⁷

In the 18th century, Leonardo's original will (which Francesco Melzi sent to his brothers with a letter in 1519) was lent to the rector of the Seminary of Pistoia, Don Conti (who then returned it to Ser Anton Giuseppe Da Vinci), and to other scholars. At the present time, though, at the Accademia dei Lincei in Rome, there remains only an empty folder.

Among those who intervened and were informed regarding the Vinci family papers were the families Masetti (and their farmer Piero Farsetti), Martelli, Comparini, Corsi (together with the priest Giovanni), Mazzetti, Cavallini, Romanelli, the Mayor Raffaello Colzi, as well as the Santini, Cerboni, and Vignozzi families.

In 1872 Carolina Cavallini (the wife of Raffaello Romanelli and the daughter of Annunziata Vinci) and Laura Cavallini nei Santini declared, and her sister Laura provided confirmation, that (at least a part of) the Da Vinci papers had been kept by their father in a pillow case, and that they had also kept them there. Then they were taken by the Mazzetti, the Comparini, and then by the priest Corsi "*che le rese a nostro padre, dicendo che mancavano le meglio carte; e poi ce le prese il Vinci di Montespertoli*" (who gave them back to our father, remarking that the best pages were missing; then the Vinci of Montespertoli took them). However, the Marchese Mazenta paid three *paoli* a month for many years to Angelo of the Cavallini family (in exchange for what, we do not know).¹⁸

In presentations at various conferences between 1979 and 1983, published only in part in 1988, I announced some clues I had found in the Mugello, where Ser Antonio Giuseppe (the notary who was the principal custodian of the Da Vinci family papers) had been Podestà (after which – and this is a new discovery – he was Podestà at Castellofiorentino and at Pomarance). Despite several suggestions, we have not yet obtained any concrete results, neither at Vicchio, the town known for its *genius artis* (Giotto, Fra Angelico, Benvenuto Cellini), nor at Barberino, where the son of Ser Anton Giuseppe, Vincenzo Leonardo, was considered "*un ingegno particolare*" (a particular genius).¹⁹

Grandfather Antonio, procurator in Majorca, and the merchant company of a cousin rediscovered in Barcelona

On 11 August 1417, Ser Piero di Ser Guido Da Vinci, who lived in Florence in the *Popolo di San Frediano*, but acted as notary to the Podestà of Vinci, died leaving as his sole heir his son Antonio, grandfather of Leonardo.²⁰ Hitherto we had no information about Antonio prior to the cadastral return of 1427, in which it appears that he had gone to live in Vinci, initially in the house of a debtor of his, declaring: "*Sono d'età d'anni 56, senza veruno aviamento e senza ufizi che non ebbi mai*" (I am fifty-six years of age, I have no occupation, I hold no office, nor have I ever held one).

This appears to have been a stratagem to pay less tax, as it has now been clearly disproved. A new fact emerged, which we discovered by comparing and correlating documents dispersed in different places. It is a fact so extraordinary as to require further investigation, even though it appears to be undeniable: Antonio di Ser Piero in 1402 and in 1404 was in Alcudia (Majorca), as procurator to his cousin Fruosino. This activity disproves his assertion that he had never held an office and it may explain why Antonio was not a notary, like his ancestors and his son.

On the basis of these new elements, the unexpected identification of the son of Ser Giovanni and Lottiera, Fruosino, emerged (something that has hitherto been absent from the family tree and that we are currently investigating). In the late 14th and early 15th century, he was living in Barcelona with his mother, in the district of Santa Maria del Mar.²¹ In the Catalonian city he was the owner of a company that was doing business with the much more famous one owned by the Merchant of Prato, Francesco di Marco Datini, since the year of its foundation (1393). Highly relevant was his correspondence (private letters, but mostly commercial ones, receipts for merchandise, etc.) from Spain, Avignon and Italy, in particular with the agents of Datini in the Iberian Peninsula and in the ports²² of Pisa, Genoa, Venice.

It should be noted that Fruosino was also the second name of Ser Piero, Leonardo's father.

Up until now, all that was known, thanks to Dei and Monti, was a contract of 26 February 1407 (1406 in the Florentine style): "*Piero di Ser Guido da Vinci Cittadino e Notaio pubblico Fiorentino in nome suo, e di donna Lottiera vedova del già Ser Giovanni di Ser Guido da Vinci, e figliuola di Francesco Beccanugi di Firenze, abitante la medesima in Barcellona di Catalogna: Vende a Tommaso di Bartolomeo del quondam Ser Tino del Popolo di S. Michele Berteldi Cittadino Fiorentino, una Casa posta in detto Popolo ecc. Rogato Ser Lionardo di Bartoldo Cecchi Notaio Fiorentino. Cartapecora nell'Archivio generale, Mazzo 2° della lettera L, n. 35. – La Famiglia de Beccanugi fu nobilissima, che dall'anno 1284 al 1494 ebbe 39 volte il Priorato, e sette volte il Gonfalonierato di Giustizia*" (Piero di Ser Guido da Vinci, Florentine citizen and public notary, in his own name, and in the name of the woman Lottiera, widow of the late Ser Giovanni di Ser Guido da Vinci, and daughter of Francesco Beccanugi of Florence, living in Barcelona in Catalonia: sells to Tommaso di Bartolomeo, son of the late Ser Tino of the Popolo of San Michele Berteldi, Florentine citizen, a house located in the said Popolo, etc. Drawn up by Ser Lionardo di Bartoldo Cecchi, Florentine notary. Sheepskin parchment in the general archive, bundle 2 of the letter *L*, n. 35. – The Beccanugi family are very noble, and from the year 1284 to 1494 have held 39 Priorships, and 7 times the Gonfaloniership Gonfalonier of Justice).

A mysterious and hitherto inexplicable memorandum, incomplete and covered with an ink stain, can be found on *fol. 81r* of Leonardo's *Codex Atlanticus* (dated 1509), where we read the date "*addì 5 di luglio 1458*" (this day of 5th of July 1458) and the phrase "*Dimmi s... / Antonio di...*". Could this be a reference to his grandfather's death, who in 1458 was eighty-five, and certainly had already died by 1462 (when Ser Piero

signed himself “*olim Antonii*,” i.e. son of the late Antonio), and about whom we have no information later than February 1458?²³ It makes one wonder whether Antonio was buried in Vinci: in a mass grave, or inside the church of Santa Croce, in a family tomb (as was the case, according to documentation, for other prominent families of the town)? Or was Antonio perhaps buried in the district of Santo Spirito, in Florence?²⁴ His cadastral returns were in fact filed in the *quartiere* of Santo Spirito, Gonfalon of the Dragon. However, Ser Piero, a few years later, had his own family’s tomb installed in the Badia Fiorentina.

“Pagola,” the daughter of Ser Piero di Ser Guido and Paolo di Leonardo?

Still shrouded in mystery is the figure of “Pagola” of Ser Piero di Ser Guido, the sister of Leonardo’s grandfather, Antonio di Ser Piero di Ser Guido, who was brought to my attention by Renzo Cianchi and then by his son Francesco as an important lead to Sovigliana di Vinci.²⁵

Another line of investigation to follow outside of Vinci and Florence is that of Violante di Antonio (Leonardo’s aunt), who was born on 31 May 1432, and in the cadastre of 1458 is recorded as the wife of Simone d’Antonio da Pistoia.

It cannot be altogether excluded that Leonardo, while still very young, had a child; but there is increasing doubt in respect of “Paulo de Leonardo de Vinci da Fiorenze,”²⁶ a protégé of the Medici and of the Bentivoglio (lords of Bologna who had dealings with Leonardo’s father Ser Piero), as no new documents or clues have emerged since the valuable discovery published by Carlo Pedretti²⁷ and my own hypotheses, which tended to promote research in all directions: from a surprising coincidence, to a doubt that the reference might allude to an illegitimate son not of Leonardo but of his father (who may have wanted to remain anonymous).²⁸

Female descendants

We have also sought to fill a gap left deliberately by earlier scholars, which has not hitherto been filled. Uzielli observes, at the root of the family tree of the Da Vinci family, that “*in questo albero si sono omesse le donne della terza generazione succeduta a quella di Leonardo e delle generazioni seguenti*” (in this tree the women of the third generation have been omitted after that of Leonardo and of the following generations).²⁹

Certain omissions seem to be related to old-fashioned prejudices; they might also have been because of the difficulties involved in tracing female descendants owing to the change of surname. For us, what is important is also the historical value associated with places and the transmission of documents. Moreover, the particular genetic interest in the male line corresponds to that of the female line, as may be highlighted by future developments in the Project’s research.

From the branch of Domenico Matteo di Ser Piero descends a series of women who are not mentioned in the family tree, and whose names in some cases appear more than once. We have identified, for example, the following: Ada, Agata, Anna Maria, Annunziata, Antonietta, Assunta, Bartolomea, Boba, Caterina, Dina, Domenica, Dorotea, Elena, Giovanna, Iolanda, Lucia, Lucrezia, Maddalena, Maria, Orsola Carolina, Patrizia, Pieranna, Teresa etc., without forgetting the wives because of the historical interest in family ties and places – the research continues.

Grandmother Lucia and the three female second cousins of Leonardo from Bacchereto

Investigations into the family of Leonardo's paternal grandmother, Lucia di Ser Piero di Zoso di Giovanni, began at Bacchereto, in the Comune of Carmignano, in 1973, initially in the field and then in the archives.

The origins of Leonardo's grandmother had not been thoroughly studied before and could have seemed to be no more than a legend of the popular tradition, until I discovered ceramic fragments in the soil of the Zoso family's land, including their kiln at Bacchereto (*"in luogo detto La Croce a Toia"*), land that subsequently belonged to Ser Piero Da Vinci.³⁰

After various surveys, lectures and publications,³¹ I was able to organize an exhibition in Florence³² and to write a piece for the catalogue of an exhibition held at Artimino.³³

In 1371, Zoso di Giovanni was an *orciolaio* (a maker of terracotta jars) in Bacchereto and he can be found documented up until 1403,³⁴ one of his three children was to become the great grandfather of Leonardo, and a notary, with the same name as Leonardo's father: Ser Piero (di Zoso).

In 1427, Baldassarre di Ser Piero di Zoso, the brother of Leonardo's grandmother Lucia, and therefore Leonardo's great uncle, was left orphaned and alone at the age of thirteen.³⁵ Ser Baldassarre later had among his clients Bernardo Machiavelli, the father of the famous Niccolò, friend and supporter of Leonardo.

In the cadastral return of 1480, he declared, among other things, ownership of a master house and of the terracotta-jar kiln at Toia di Bacchereto, which in 1482 he gave to Ser Piero, Leonardo's father, in exchange for an undertaking on the part of Ser Piero Da Vinci to provide dowries for the three daughters of Ser Baldassarre, born from his marriage to Mattea, thirty years his junior:³⁶ Bartolomea (Mea), Caterina, and Dorotea.³⁷ But of these three daughters of Ser Baldassarre, Leonardo's second cousins, we do not yet know the possible descendants, although we do know the names of their husbands: Caterina married Domenico di Michele da Vinci, Mea married Giovanni di Nuto da Carmignano, and Dorotea married Papino di Nanni di Papino da Santa Lucia, the grandson of Papino di Nanni Banti, who was a witness at Leonardo's christening.³⁸

It is interesting to note that Dorotea, at the age of thirteen, was included by Ser Piero Da Vinci among his “*bocche*” (mouths to feed) in the cadastral return of 1498; and that the names Bartolomea, Matteo, and Dorotea recur in the Da Vinci family tree.

To sum up: documents attest that Lucia, Leonardo’s grandmother, was originally from Bacchereto; the reference to Leonardo valorizes the rediscovery of Toia and Bacchereto, where in the 15th century there were at least thirty kilns for the production of artistic ceramic ware, all of which had practically disappeared by the 16th century.

It is more than likely that Leonardo commenced his artistic activity between the ages of eight and ten, not only in Florence but also at the family kiln at Toia. Ser Piero, Leonardo’s father, married off his three cousins, the daughters of Baldassarre, between Vinci and Carmignano. We are also searching for the graves of the Zoso family and of their possible descendants, not only in Bacchereto.³⁹

Caterina, Accattabriga and their descendants

In 1457, Leonardo’s grandfather, Antonio, included among the “*bocche*” (mouths) of his family five-year-old Leonardo: “*Lionardo figliuolo di detto Ser Piero non legittimo nato di lui et della Chaterina, che al presente è donna d’Achattabriga di Piero del Vaccha da Vinci*” (Lionardo, illegitimate son of the said Ser Piero, born to him and to Chaterina, who at present is the wife of Achattabriga di Piero del Vaccha da Vinci).⁴⁰

But the identity of Caterina, Leonardo’s mother, and of her husband, Leonardo’s stepfather, remained unknown until 1975, when an initial series of questions received precise answers thanks to the publication of Renzo Cianchi, which provided much information about the family of Accattabriga and their houses in the environs of Vinci, at San Pantaleo, and their five children, Leonardo’s half-siblings: Piera, Maria, Lisabetta, Francesco, and Sandra.

The publisher Giunti commissioned me to collaborate with Cianchi for this publication, and therefore I assisted him in the archives and took photographs of documents and locations. Subsequently, I continued the research on my own, also with a view to updating and integrating Leonardo’s family tree.

Accattabriga was therefore identified with Antonio di Piero di Andrea di Giovanni Buti del Vacca (known also as “*del cischia*”), who was documented in the year of Leonardo’s birth as a kilnman.⁴¹

The Buti family were important in the history of Vinci: in the *Registrum officiorum* of the Comune for the year 1396, Giovanni Buti appears with his three sons, Andrea, Pasquino, and Marco.⁴² In 1427, in the house of Campo Zeppi, there were nineteen “*bocche*” with four heads of the family: Pasquino di Giovanni (aged 66), his son Monte (aged 40), his brother Marco di Giovanni (aged 61), and Piero di Andrea di Giovanni (aged 36) with his son Antonio (Accattabriga, aged 1). The latter had three siblings: Iacopo, Benedetto, and Betta.⁴³

But we are primarily interested in the family and living conditions of Leonardo's stepfather, and above all Caterina, of whose origins and occupation prior to the birth of Leonardo, we know very little. In fact, she is the only person whose patronym does not appear in any document concerning her; she is the only one whose age is not included in Accattabriga's first cadastral return (1460).⁴⁴ Thus far, it has been impossible to identify Leonardo's mother with any Caterina in Vinci or thereabouts, despite the efforts of many scholars, from Renzo Cianchi to Giovanni Micheli (not to mention ourselves). Recently, Elisabetta Ulivi has investigated new hypotheses.⁴⁵

Historiographical and literary traditions have so far traced only a vague identity for Caterina, not having found any supporting documents: Was she a peasant girl from Vinci? The daughter of a woodcutter from Cerreto Guidi? Around her, fanciful legends and hypotheses have formed. One thing of which we can be certain is that she was not the serving girl of the non-existent hostelry of Anchiano (which was invented by the Russian novelist Dmitry Merezhkovsky in his *The Romance of Leonardo da Vinci*⁴⁶).

Already in 1975 Cianchi revealed to me his extraordinary theory, in some respects convincing but in others outlandish and surprising, that Caterina was a slave; but we did not publish it then,⁴⁷ nor for many years afterwards.

Only in 2002 did I consider it appropriate to present the hypothesis that Caterina was a Middle Eastern slave (without revealing details of Cianchi's identification, out of respect for the deceased scholar), on the basis of a series of new elements and a chain of documentary evidence and contextual considerations, as well as a process of exclusion. The idea caused a sensation around the world. There was curiosity and agreement, but also disbelief and some irritation, possibly because the phenomenon of slavery in our Renaissance seems to have undergone a conscious denial.⁴⁸ Yet in Florence, at the time when Leonardo was born, there were at least 500 female slaves.⁴⁹

From research originating from the "Archive of Fingerprints from Leonardo's Works" at the Museo Ideale,⁵⁰ Luigi Capasso (of the Institute of Anthropology at the University of Chieti) claimed to recognize Arabic characteristics, or at least eastern Mediterranean ones, in respect of our hypothesis of "Caterina the slave."⁵¹

In 2007, in a seminar in the church of San Pantaleone at San Pantaleo, entitled "Caterina and Leonardo, Campo Zeppi and Accattabriga,"⁵² I illustrated the slave theory with new documents and maps.

In 2008, together with Renzo's son, Francesco Cianchi, we finally published the documents on which Renzo's theory had been based.⁵³ Today, the hypothesis that Caterina came from the Middle East and can be identified with the female slave of Vanni di Ser Vanni, in the house that was subsequently owned by the Da Vinci in Via Ghibellina in Florence, is definitely the most likely and reliable, but having found neither a sales deed, nor a baptismal record, nor a *liberatio sclavae*, we cannot consider it a certainty.⁵⁴

Other doubts concerning Caterina relate to her removal to Milan to stay with Leonardo in 1493 (Accattabriga having probably died after 1490⁵⁵), her death in 1494, and the place of her burial.

A new document, recently recovered at the State Archives in Milan,⁵⁶ seems to specify the date of Caterina's death: Thursday 26 June 1494, in the district of Porta Vercellina, in the parish of Santi Nabore e Felice, "*Chatarina de Florentia, di anni 60, è morta per febbre terzana*" (Chaterina from Florence, aged 60, died from tertian fever).

There are, however, a few discrepancies, not so much in the indication of the city of provenance (Florence rather than Vinci), or in the dating of a note in the *Codex Forster II* (between 1494 and 1496), but in the difference of age: if in the cadastral return of 1487 Caterina was declared to be of "*anni 60*," then in 1494 she would have been sixty-seven. But, as is known, indications of age in cadastral returns are often approximate. The same problem exists for Accattabriga.⁵⁷

However, what is convincing is the reference to the district of Porta Vercellina, where Leonardo worked.

Some handwritten notes by Leonardo,⁵⁸ including expenses for the burial of Caterina,⁵⁹ definitely seem to confirm the hypothesis that she was his mother, and attest that there was a continuous intense emotional relationship lasting forty years, even though it is not otherwise documented or recorded in biographies of the artist and scientist. The apparent coldness of Leonardo's calculation of the expenses for his mother's funeral is one of its characteristics, and would be repeated in his annotation on the death of his father in 1504.⁶⁰ Given the modest outlay, it was certainly not an illustrious entombment, and it is very unlikely that we will ever be able to find Caterina's remains.

Caterina's other children

Her only legitimate male child, Francesco, is mentioned as being twenty-six in the cadastral return of 1487, but with the note "*morto d'una spingarda a Pisa*" (killed by a springald in Pisa).⁶¹

An ongoing, though still incomplete, investigation is that relative to the four daughters of Caterina and her three granddaughters, the children of Lisabetta. The eldest daughter, who was named Piera possibly in homage to Leonardo's father, was born between 1453 and 1454;⁶² she was married on 21 January 1475 (1474 in Florentine style)⁶³ in the *Popolo di San Pantaleone* at San Pantaleo, in the place called Campo Zeppi, and in the house of Accattabriga and Caterina, to Biagio di Andrea of the late Piero del Bianco di Vinci, who "*al presente*" (at that time) was living at Santa Maria a Monte in the lower Arno valley.

Almost certainly, Piera moved to Santa Maria a Monte, but we still do not know whether she had any children;⁶⁴ however, by 1487 Piera was once more listed among the "*bocche di femmine*" (female mouths to feed) in Accattabriga's house at Campo Zeppi; and in 1504, aged fifty, she is recorded as being a widow and the head of the family in the house at Campo Zeppi, with no mention of children. Presumably she was the last heiress of Accattabriga, but in the cadastral return of 1520⁶⁵ she was no longer in possession of

assets, as we can deduce from the note: “*Chi possiede paghi e non Monna Piera. Gravate i beni*” (Who owns pays, but not Monna Piera. Assets impeded).

Of Caterina’s other daughters: Maria (born 1457)⁶⁶ married Pasquino di Andrea di Meo di Piero Vannucci “*alias di Larino*” of the *Popolo di Santa Maria* at Faltognano on 16 August 1478, but she died before 1487, presumably childless.⁶⁷

Lisabetta (born 1458/1459)⁶⁸ married after 1487, and in 1504 was a widow aged forty-six, having had three daughters: Maddalena (14 in 1504), Antonia (20) and Lucrezia (10), but we do not know the name of her husband, nor whether her daughters married, and whether, as is likely, they had children. Lisabetta died later than May 1516.⁶⁹

As for the youngest, Sandra, who was twenty-four in Accattabriga’s cadastral return of 1487, we presently have no further information: she does not appear in the return of her sister Piera in 1504; Was she dead, or was she married with children?

All traces of the family of Caterina and Accattabriga disappeared from Campo Zepi early in the 16th century. Did their descendance continue through their daughters and granddaughters?

Research to answer such questions is underway, also regarding their burial places.

Domenico Matteo

Domenico Matteo was born at eleven o’clock on 21 February 1483⁷⁰ (to Ser Piero and Margherita di Francesco Giulli), in the house in Via Ghibellina that Ser Piero had inherited via a codicil in the will of Vanni di Niccolò di Ser Vanni. This house was at the centre of a long dispute, in part because Vanni was regarded as a usurer, and in part because Ser Piero had to give up his right to live there until the death of Grandmother Agnola, Vanni’s widow, to solve the problem of his having made Caterina, the slave, pregnant, probably Leonardo’s mother.⁷¹

Around 1506, there was an affectionate exchange of letters, with some occasionally bitter and pungent reflections, between Leonardo and his “brother” (but it could have been in fact one of his close friends). Some scholars thought it was Domenico Matteo;⁷² but this could only have been possible if he were an illegitimate son or the son of a former wife unknown to us; so far we are not aware of any of Ser Piero’s sons becoming a father at that time or before Leonardo’s death.

“Amantissimo mio fratello, solo questa per avisarti come ne’ di passati io ricevetti una tua, per la quale io intesi tu avere avuto erede, della quale cosa intendo come hai fatto con strema allegrezza: il che, stimando io tu essere prudente, al tutto son chiaro come i’ sono tanto alieno da l’ avere bono giudizio, quanto tu dalla prudenza; con ciò sia che tu ti se’ rallegrato d’averti creato un sollecito nemico, il quale con tutti li sua s[t]udi disidererà libertà, la quale non sarà senza tua morte.”

(Most beloved brother, this just to let you know, as in the past, I received

one of yours, from which I learned that you have had an heir, and I understand you are extremely pleased about it. Since I had formerly judged you to be endowed with prudence, I am now convinced that I was as far from having good judgement as you are from being prudent, for you are congratulating yourself on having created a vigilant enemy, who with all his heart desires liberty, which he will only get with your death...⁷³

Domenico Matteo was married on 22 November 1536⁷⁴ to Fioretta di Stefano Vittori da Bacchereto, in the church of Santa Maria al Pruno; the nuptial mass was celebrated by the priest Giovanni di Pietro da Prato, with two witnesses from Lamporecchio. He made his will twice at Costareccia: on 14 April 1544 and on 26 August 1549.⁷⁵ He, too, (together with his brothers Giovanni, Guglielmo, and Bartolomeo) was among the affiliates of the Compagnia dello Spirito Santo di Vinci. He died “*entro il 1563, come si deduce da un documento di quell’anno*” (by 1563, as is deduced from a document of that year).⁷⁶

He is the originator of the branch of descendants of Ser Piero that reaches down to us via the direct male line.

In 1772, Durazzini, retracing the family tree of Dei, wrote under the name of Domenico: “*Autore de’ viventi*”⁷⁷ (author of the living). This definition was then adopted in the very brief family tree in an edition of Leonardo’s *Trattato della Pittura*, in reference to the descendants of Ser Piero Da Vinci.⁷⁸

Domenico was addressed as “Ser,” even though he was not a notary, because of the esteem in which he was held in Vinci and in Florence, and by his brothers, who delegated him to withdraw part of the money they had inherited from Leonardo from an account at the bank of Santa Maria Nuova.⁷⁹ It was also him, together with his brothers Antonio and Lorenzo, who on 4 May 1533 paid the last ninth of the dowry of Dorotea di Ser Baldassarre di Zoso.

In 1534, he entered definitively into possession of Costareccia, his house still in the Comune di Vinci, but in the parish of Santa Maria del Pruno di Orbignano (now in the Comune di Lamporecchio).

A family tree that has remained practically unknown (like so many documents published in vain), attached to a document filed during a dispute, on 1 July 1700, between Piero di Lorenzo di Piero di Lorenzo di Domenico di Ser Piero Da Vinci (a Florentine citizen born in 1630) and his debtors, highlights the importance of the descentance of Domenico Matteo, with a succession of names often repeated throughout the different generations: (Ser) Guido – Ser Piero – Antonio – Ser Piero (Leonardo’s father), from whom only eight children are shown and all males (Antonio, Giuliano, Lorenzo, Domenico, Benedetto, Pandolfo, Guglielmo, and Bartolomeo); it continues with the descendants of Domenico: Lorenzo – Piero Antonio – Lorenzo – Piero.⁸⁰

The *Libro dei Morti* (Register of deaths) for the parish of Orbignano was instituted at the time of the priest Baronto Comparini and started from 1 August 1592. It provides no information about Ser Domenico Matteo or his likely burial in Santa Maria del Pruno.

His son, Lorenzo, died on 20 January 1594 and was buried in the “*chiostro sotto la cucina*” (cloister beneath the kitchen); while his wife, Boba, died on 17 April 1608 and was buried in the same cloister. They had two sons: Antonio and Piero.

More than twenty descendants of Domenico Matteo were buried in Orbignano: in the cloister and in the cemetery, in the graves of men, women, and children.

His descendant in the 18th century and owner of Costareccia, was Ser Antonio Giuseppe Da Vinci, who made his will on 18 April 1795 and stated that he wished to be buried in his “*propria sepoltura che esiste nella chiesa di Santa Croce di Vinci*” (own tomb that exists in the church of Santa Croce in Vinci). We have reconstructed a series of unpublished information: on the 22 May 1803 he was buried (as before with other family members) “*nella sepoltura Da Vinci*” (in the Da Vinci tomb), situated in that same church in front of the main door. This information is important, even though the old church in Vinci was later completely transformed into the neo-renaissance style during the years 1929-1935.

Since his son Vincenzo Leonardo died at thirty-two (1793), his two daughters became his universal heirs; one married a Corsi, and the other a Galletti (and this too, as we shall soon see, is particularly significant).

Guglielmo di Ser Piero and Guglielmo di Piero di Guglielmo

In addition to the house in the village of Da Vinci, Guglielmo came into possession, from the legacy of his brother Benedetto, of the house in Anchiano that Ser Piero had acquired after 1480 from the Servite friars in Florence. On 13 May 1542 he made his will, expressing his wish to be buried in Santa Lucia at Paterno. He was certainly already dead by 1551.⁸¹

Guglielmo was one of the few members of the Da Vinci family to be nominated for an important public office in Florence: he was in fact “*squittinato*” (elected) to the priorate for the Arte Minore in the district of Santo Spirito, Gonfalonier of the Dragon, in 1524.⁸²

In the updated 1804 edition of Leonardo’s *Trattato della Pittura*, we read: “*Guglielmo, una delle linee giunta sino a noi*” (Guglielmo, one of the lines that has arrived down to us),⁸³ but this research is yet to be completed.

In documents of 1599 associated with the division of the estate of Piero di Guglielmo di Ser Piero, it emerged that some of his sons were living far from Tuscany: Leonardo in Avignon, Piero in Naples, another son, friar Guglielmo, was in Siena; in 1629 he bequeathed all his possessions to the convent of Santa Lucia alla Castellina (in the Florentine hills).

Burials from the 15th to the 20th century

Our investigations into burial sites began in Amboise in 1977, in preparation for the assignment of twin status between the municipalities of Vinci and Amboise (1978), to mark the places of Leonardo's birth and death.

In 2004, the Institut International de la Reconstruction Anthropologique in Paris proposed a collaboration with Museo Ideale Leonardo Da Vinci to examine the tomb of Leonardo Da Vinci and the remains therein, following the reconstruction of Arsène Houssaye in the second half of the 19th century, in the chapel of Saint Hubert in Amboise Castle. Contacts were made, but the administrators of the Castle replied negatively, then and in the ensuing years.

Research on the Da Vinci tomb in the Badia Fiorentina was launched as part of the exhibitions "Leonardo Scomparso e Ritrovato" (1988) and "Leonardo e l'Europa" (2001). Consultations began with the engineer Maurizio Seracini of the studio Editech and with RACIS (Raggruppamento Carabinieri Investigazioni Scientifiche [the Carabinieri's division for scientific investigations]).

Of particular significance is the document concerning the will of Benedetto di Ser Piero, Leonardo's brother, drawn up on 17 August 1530 while he was dying of the plague in the town of Vinci in Lazzeretto, Zollaio. He bequeathed his estate to his mother Lucrezia di Guglielmo di Gherardo Cortigiani, Ser Piero's fourth wife, and specified that after Lucrezia's death his estate was to pass to his brother Guglielmo di Ser Piero, and to his and Leonardo's nephew, Pierfrancesco di Bartolomeo, known as Pierino Da Vinci, a famous sculptor in the circle of Michelangelo. Giorgio Vasari dedicated one of his *Lives* to Pierino, who died at a very early age in Pisa, probably in 1553.

It is noteworthy how Benedetto specified that his body was not to be buried in Vinci, but in the Da Vinci family tomb in the Badia Fiorentina. He added a note that is of great historical importance concerning the siege of Florence that year: "*Civitas erit pacificata, et expedita a vexatione belli etc. Et hoc reliquit in discretione suorum fratrum et heredum.*" Benedetto was in fact buried at the Badia Fiorentina on 31 October 1531.⁸⁴

For ancient tomb burials, apart from those marked by tombstones with an inscription, it is extremely difficult to distinguish the remains of specific individuals in mass graves.

Research is nevertheless important for an understanding of the places, for information related to the family tree, and for adding pieces to the mosaic of history.

Overall, research on graves carried out by the Museo Ideale Leonardo Da Vinci has encompassed Florence (San Biagio or Santa Maria Sopra Porta); Vinci (Santa Croce); Orbignano di Lamporecchio; San Pantaleo, Faltognano and Santa Lucia at Paterno (in the Comune di Vinci); Bacchereto; and more generally Pistoia, Santa Maria a Monte; Pisa; Livorno; Milano (Santi Nabore e Felice); Naples; and Barcelona. Somewhat particular are the cases of the religious members of the family, who migrated far from the Da Vinci family home, to places where they were no doubt buried and are perhaps recorded

in inscriptions that have not yet been found. For example: the priest Lorenzo at the Pieve di Larciano (mentioned in 1724); in Florence, Suor Maria Clemenza at the monastery of Fuligno (convent of Sant'Onofrio) and Suor Innocenzia at the monastery of Santa Brigida al Paradiso; Jacopo, a Capuchin friar, known as Fra' Tommaso.

Other singular cases are those of Lorenzo di Ser Piero, author of a *Confessionario* and of a book of *patientia*, an official at the *Dogana* (Customs and Excise) of Livorno (and of Pisa); and of the cavalry officer Leonardo di Piero di Guglielmo Da Vinci, who fought in Hungary and was later imprisoned in Volterra.⁸⁵

Of even more historical importance – for comparative purposes and for future DNA research – are the surveys with which we have identified the graves where Ser Piero Da Vinci's descendants were buried in the 20th century. These can be found in many different cemeteries, from Sovigliana to Fibbiana and Santa Maria, and from Botinaccio to Sammontana.

The Leonardo Project

In 2015, having been invited by Professor Brunetto Chiarelli to take part in the Leonardo Project, we presented information on the database of fingerprints from Leonardo's works at the Museo Ideale Leonardo da Vinci (excluding forgeries) and discussed several hypotheses regarding DNA research, and suggested that we apply such research to the existing tombs of Raphael in the Pantheon in Rome and of Michelangelo in Santa Croce in Florence.

Continuing our collaboration with the partners of the Project, and considering the exceptional level of research carried out by the scholars involved, particularly that of Anne Leader on the burials at the Badia Fiorentina and Rhonda Roby (J. Craig Venter Institute) on the family tree, we decided to put an end to our procrastinations and reveal the identities of the living descendants of Leonardo Da Vinci's father.

To proceed with this and the next more detailed communication of unpublished data, we were greatly encouraged both by the positive attitude of the main representative of the descendants of Ser Piero, our friend Giovanni (still anonymous nine years after having verified this fact), and by the methodological considerations put forward by David Caramelli, of the Department of Biology, Laboratory of Molecular Anthropology and Paleogenetics, at the University of Florence.

Thus, we can finally update the family tree by tracing, through a direct and uninterrupted line, the descendants of Tommaso Gaspero and of his two wives (Maria Teresa Boldrini and Maria Fiorini), continuing with Angelo and his wife Margherita, and with their six children and twelve grandchildren – so as to arrive at our own time, and at the opportunity of sequencing the DNA of Leonardo Da Vinci, in order to verify whether the remains at Amboise Castle are indeed his.

Endnotes

- 1 In 1973 the collection of “Strumenti-Memoria del Territorio” (Memorabilia of the Territory) of Vinci (documents, archaeological and demo-ethno-anthropological finds) was started in the ancient cellars of the castle of Vinci (which since 1993 have hosted the Museo Ideale Leonardo Da Vinci, not many metres from what used to be the town mill, run by Leonardo’s father and uncle, and from the hostel of his brother, Giovanni). In the past 23 years, Museo Ideale has produced numerous communications on the town of Vinci and on the family of Leonardo.
- 2 Renzo Cianchi (1901-1985) was co-founder and director of the Biblioteca Leonardiana in Vinci, which was opened in 1938. He was also director of the Museo Leonardiano (opened in 1953) until 1968. He was succeeded by Paolo Galluzzi.
- 3 Including local *Vinciatesi* pamphlets, by Don Quirino Giani, Padre Dionisio Pacetti, Siro Taviani, and Dino Salvo Salvi.
- 4 Ulivi (2008), pp. 41-42.
- 5 Vezzosi (2008), p. 31.
- 6 Origin from the town of Vinci explains other coincidences and homonyms, such as: Antonio di Bernardo da Vinci and Tommaso di Marco de Vinci, two officials at San Miniato in the 15th century.
- 7 Di Coppo Stefani, M. (1779), pp. 79, 87, 102, 104.
- 8 Crollalanza (1886-1890), Vol. III, p. 99.
- 9 *Ibid.*.
- 10 BNF, Cirri, Blasonario Fiorentino, Vol. 10, p. 638.
- 11 *Ibid.*.
- 12 Vezzosi (1989), pp. 18-22.
- 13 Rossoni (2014), p. 3279.
- 14 In the collection of Museo Ideale Leonardo Da Vinci.
- 15 Uzielli (1872), pp. 108-109.
- 16 He died on 21 maggio 1803 “*a ore 4 di sera*” (BNF, Fondo Uzielli, 82). Renzo Cianchi (1977, p. 3) gives his dates as 1726-1801.
- 17 Vezzosi (1989), p. 20.
- 18 BNF, Fondo Uzielli, Striscia 82.
- 19 Vezzosi (1989), p. 20.
- 20 Cianchi, R. (1953), p. 67 & ss.
- 21 AHBP (Barcellona, Archivio Storico dei Protocolli), 79/12, c. 44r (data estrema 1407).
- 22 The *fondachi* were trading posts conceded to the merchants of the maritime republics, where they had the right to judge their fellow citizens and were exempt from paying customs duty on their merchandise.
- 23 Vezzosi (2008), p. 38.
- 24 “*Ecco altre notizie avute dal proposto... Il sepolcro gentilizio della famiglia Vinci era nella chiesa di Santo Spirito a Firenze,*” BNF, Fondo Uzielli, Striscia 82.
- 25 Vezzosi (2008), p. 22.
- 26 ASF, Mediceo Avanti il Principato, 37, c. 49, letter from Giovanni Bentivoglio to Lorenzo de’ Medici in Florence, 4 February 1479.
- 27 Pedretti (1992), pp. 120-121; Pedretti (2001), pp. 43-47.
- 28 Vezzosi (2000), p. 40; Vezzosi (2008), p. 94.
- 29 Uzielli (1872), p. nn (but 222).
- 30 Communication from A. Vezzosi to the Soprintendenza d’Antichità d’Etruria, 14 May 1973.

- 31 Such as *Una Sera con Leonardo Da Vinci*, Bacchereto, 1989, and *Leonardo da Vinci. Arte e Cultura della Terra. Il Vino di Leonardo*. Firenze: Morgana, 1991.
- 32 *Carmignano, Territorio di Vino*, Firenze, 1993.
- 33 Vezzosi (1992).
- 34 Prato, Archivio di Stato, Spedale del Dolce, 21, c. 90r. V. anche Cora (1973).
- 35 ASF, Catasto 76, c. 274r.
- 36 Vezzosi (1992), p. 9 ff.
- 37 ASF, *Decima repubblicana*, 9 (1498, S. Spirito, Drago, 2), c. 1165r.
- 38 See Cianchi, R. (1977), p. 6. See also Malvolti (2015), p. 42.
- 39 The most recent lecture by A. Vezzosi was “Da Leonardo a Duchamp. La Gioconda è Nuda,” Carmignano, 4 May 2013, with interventions by C. Pedretti and S. Pezzato.
- 40 ASF, Catasto 1457, Quartiere Santo Spirito, Gonfalone Drago, f. 796, c. 591.
- 41 Cianchi, R. (1975), p. 13 and n. 18.
- 42 ASF, Statuti di Vinci, n. 935, *Registrum Officiorum*; V. Cianchi, R. (1975), p. 7.
- 43 Ulivi (2009), p. 3.
- 44 Only in the cadastral return of 1487 does she appear as “*Monna Chatterina donna d’Antonio d’età d’anni 60.*” See the following page.
- 45 E. Ulivi (2009). In this study, she cleverly compiled and analyzed a list of all the women in Vinci named Caterina, whether married or unmarried, aged between ten and thirty-five in the Catasto of 1451, and those aged between eighteen and forty-three in the Catasto of 1459; she identified 26 women in all, and came up with a possible alternative to Caterina the slave, i.e. Caterina di Antonio di Cambio (who, for the moment, does not convince me).
- 46 Merezhkovski, D. (1901), still in print and still read.
- 47 With the exception of a question-mark in the interview given by Cianchi to Neera Fallaci, sister of Oriana, and published in the weekly *Oggi* in October 1975.
- 48 Sabato (2008), p. 26.
- 49 *Ibid.* pp. 30-31.
- 50 In 2000 on the occasion of the exhibition “Leonardo e l’Europa,” we officially set up at the Museo Ideale Leonardo Da Vinci an initial “Archivio delle Impronte Digitali” (Fingerprint Archive), which we drew to the attention of the Carabinieri (RaCIS e Tutela del Patrimonio Artistico) and of the Institute of Anthropology in Chieti. See also D’Anastasio, R., Vezzosi, A., Gallenga, P.E., Pierfelice, L., Sabato, A., Capasso, L. (2005). Anthropological Analysis of Leonardo Da Vinci’s Fingerprints. *Anthropologie*, XLIII/1: 57-61.
- 51 12 May, symposium organized by the Museo Ideale on the occasion of “Genio Fiorentino” 2007, at the Museo del Bigallo: “L’impronta del Genio,” with D. Lippi, L. Capasso, G. De Fulvio, and A. Vezzosi.
- 52 On 9 September 2007, for the initiative “Riscoperte nella Terra Natale di Leonardo. La Chiesa e la Casa della Madre di Leonardo, Caterina, a San Pantaleo di Vinci.” See also Vezzosi (2014).
- 53 Cianchi, F. (2008). See also Vezzosi (2008), pp. 24-25, 28.
- 54 Although other very interesting documents were discovered by Ulivi, she sought in vain among documentation concerning female slaves living in Florence at the time. See (2009), p. 8, n. 27. See also Sabato (2008), p. 31.
- 55 In 1490 he is cited with his son Francesco in the Campione cadastral return of that year.
- 56 Villata (2005), pp. 154, 152-153.
- 57 In the cadastral return of 1427 he is a one-year-old; in 1460 he is thirty (instead of thirty-four); in 1487 he is sixty-four (instead of sixty-two).

- 58 Between 1473 and 1488, we find in the *Codex Atlanticus* a note by Leonardo: “*Dimmi come le cose passano di costà e sappimi dire se la Chaterina vuole fare*” (c. 195r). Caterina is mentioned by Leonardo twice elsewhere: in the *Forster III* (f. 88r) and in the Ms. H (f. 64v), in the first case referring to her going to Milan (“*A dì 16 di luglio Catelina venne a dì 16 di luglio 1493*”) and in the second to a list of expenses (twice “*Caterina soldi 10*” with the date 29 January 1494).
- 59 In the *Codex Forster II*, Leonardo notes: “*Spese per la socterratura di Caterina: in libbre 3 di cera, soldi 27 – per lo cataletto, soldi 8 – palio sopra cataletto, soldi 12 – portatura e postura di croce, soldi 4 – per la portatura del morto, soldi 8 – per quattro preti e quattro chierici, soldi 20 – campana, libri, spugna, soldi 2 – per li cinque sotterratori, soldi 16 – all’anziano, soldi 8 – per la licenza agli ufficiali, soldi 1 – in medico, soldi 5 - zucchero e candele, soldi 12 – in tutto soldi 123*” (Expenses for the burial of Caterina: for 3 pounds of wax, 27 soldi; for the catafalque, 8 soldi; for the drape over the catafalque, 12 soldi; for carrying and positioning the cross, 4 soldi; for carrying the corpse, 8 soldi; for 4 priests and 4 clerks, 20 soldi; for bell, books and sponge, 2 soldi; for the 5 gravediggers, 16 soldi; for the old man, 8 soldi; for the licence from the officials, 1 soldo; for the physician, 5 soldi; for sugar and candles, 12 soldi. Total, 123 soldi) (f. 64v).
- 60 “*Addi 9 di luglio 1504, in mercoledì a ore 7 morì ser Piero da Vinci notaio al palagio del podestà, mio padre, a ore 7; era d’età d’anni 80 [recte 83], lasciò 10 figlioli maschi e 2 femmine*” (On Wednesday 9 July 1504 at 7 o’clock Ser Piero da Vinci, notary at the palazzo del Podestà, my father, died at 7 o’clock; he was aged 80 (in fact 83), and he left 10 sons and 2 daughters), *Codex Arundel*, 272r.
- 61 ASF, Catasto 1487, Santa Maria Novella, f. 1130, c. 29v.
- 62 From the cadastral returns: her age is given as five in 1459, thirty-four in 1487, fifty in 1504.
- 63 ASF, Notarile Antecosimiano, Vol. I, c. 120.
- 64 We invited further research in a recent lecture “*Spirali della Memoria e Riscoperte d’Archivio*” given at the Teatro di Santa Maria a Monte (18 December 2015).
- 65 ASF, Decima Granducale 1536, ff. 5648/5649 of the Podesteria of Vinci.
- 66 She appears only in the cadastral return of 1460, presented on 15 October 1459, when she was two.
- 67 Ulivi (2009), p. 3.
- 68 In the cadastral return of 1487, she is recorded as being twenty-eight; in that of 1504 she was fifty.
- 69 Ulivi (2009), p. 3.
- 70 Ulivi (2008), p. 18.
- 71 Cianchi, F. (2008), pp. 13-15; Vezzosi (2008), pp. 24-25.
- 72 Brizio (1952), pp. 641-642; Vecce (1998), pp. 258-259; Villata (1999), p. 196, n.5.
- 73 *Codex Atlanticus*, f. 541v.
- 74 ASF, *Notarile Antecosimiano*, s. filza 1161, c. 546.
- 75 Cianchi, R. (1977), p. 18 (nn), n. 14.
- 76 Ulivi (2008), p. 25 and n. 90.
- 77 Durazzini (1772), p. CXXVII.
- 78 *Trattato della Pittura* (1804), p. 14, n. 1.
- 79 ASF, Ospedale di Santa Maria Nuova, 5641, cc. 193v-194r, 4 January 1520.
- 80 Archivio Storico di Empoli, Comunità di Cerreto e Vinci, f. 2007, cc. 327 ff. V. Vezzosi (1989), p.18.
- 81 Ulivi (2008), p. 27.
- 82 Monti (1909), p. 32.
- 83 Manzi (1859), p. XXV VII.
- 84 Leader (2016), p. 9.
- 85 Monti (1909), p. 31.

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