

# The story of Dante Alighieri's human remains and their anthropological analysis in the past centuries.

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**Abstract.** Dante Alighieri's death took place in the night between the 13<sup>th</sup> and the 14<sup>th</sup> of September 1321 in Ravenna, the city where Dante spent the last period of his life. In the years after Dante's death, his mortal remains underwent mysterious disappearances and were then "accidentally rediscovered" in 1865, during the renovation of the tomb. With regard to the cause of Dante's death, the prevailing historical opinion (firstly hypothesized by Stefano Cavazzuti) attributes it to malaria that the poet would have contracted on his return journey from Venice, but, until now, no historical documents have been found to prove this hypothesis. Hence, the identification of the actual cause of death still remains a challenge. In the past, two scientific analyses have been carried out on Alighieri's bones, the first in 1865 by Professor Puglioli and Bertozzi and the second in 1921 by Professor Frassetto and Sergi. Indeed, the results of these analyses gave us a lot of useful information about the actual physical features of the Poet and about some pathological data, but the obvious limitations of the technology of the past century makes particularly interesting the forthcoming scientific analysis of Dante's bones, programmed in 2021, which surely will provide us a lot of useful information about the life and the death of Dante Alighieri.

**Key words:** Dante Alighieri's death, Anthropological examinations

## Introduction

A lot of information is still missing about Dante's life: first of all, the actual date of his birth, known to be surely included between May and June in 1265, and other relevant details of his life, such as the date of marriage with Gemma di Manetto Donati and the exact number of their sons (1, 2).

About the death of Dante Alighieri, in accordance with historians (3), we know that it took place in Ravenna, where Dante spent the last period of his life, at the age of 56, in the night between the 13<sup>th</sup> and the 14<sup>th</sup> of September 1321, but the news was not disclosed until the morning of the 14<sup>th</sup>, the day of the "Exaltation of the Holy Cross".

According to the will of the Lord of the city, Guido Novello da Polenta, the funeral was celebrated

with great solemnity in the Basilica of San Francesco, with the corpse dressed in a long red dress and a crown of laurel leaves around his head, as the custom of those times for poets was. Dante's body was buried in a temporary urn placed inside the small "Chapel of the Madonna," located outside the Basilica, adjacent to the wall of the Franciscan convent.

In 1327, as recently as six years after Dante's death, the Cardinal of Bologna, Bertrando del Poggetto, (the nephew of Pope John XXII), burnt the book "De Monarchia", considering it to be heretical and even threatened to go to Ravenna to take possession of Dante's bones to burn them and scatter the ashes in the wind. This intention, however, did not come to fruition thanks to the intervention of Cavaliere Pino della Tosa (a powerful man from Bologna), the Polentani and the fierce opposition of the citizens of Ravenna.

In the following years, the city of Florence tried to obtain the poet's bones. The first request was made in 1396, since the construction of some mausoleums in the temple of Santa Maria del Fiore was planned to be dedicated to some of the most illustrious Florentine citizens, among whom Dante Alighieri would have also been included, but this request was rejected from the people of Ravenna.

The most authoritarian attempt was undoubtedly the one that the Florentines made with the backing of Pope Leo X, their fellow citizen, (as he was a member of the Medici family), through a letter from the Academy of Florence dated 20 October 1519, signed by many notable personalities from the Florentine Republic, including Michelangelo Buonarroti, who personally committed himself to creating a suitable chapel for Alighieri.

It is said (4) that in view of the imminent arrival of a Florentine delegation with the Pope's authorization to take possession of Dante's remains, the Franciscan Friars, whose convent was close to the cloister containing Dante's tomb, dug a small gallery and drilled a hole in the walls of the tomb through which they stole the bones and transferred them to the convent. Later, when the members of the Florentine delegation opened the urn, they found only a few bay leaves and three phalanges.

For centuries, Dante's bones remained in the convent where the Friar Antonio Santi placed them inside a fir, wood box after a first approximate analysis, as evidenced by an engraving on the lid of the box that reads: "*Dantis ossa. Denuper revisa die 3 junii 1677*" and another in the external part of the bottom that rested on the wall: "*Dantis ossa. A me Fre Antonio Santi hic posita. Ano 1677 die 18 octobris*".

In 1781, Cardinal Luigi Valenti Gonzaga ordered a new restoration of the urn, which he entrusted to the Ravenna architect, Camillo Morigia, and on that occasion, contrary to what is attested to in the official documents, no mortal remains of the poet were found. Subsequently, in 1810, the Franciscan convent was under pressure from the Napoleonic laws, and the friars, before abandoning their home, hid the precious wooden box under a threshold near the church.

### The scientific analyses of the skeleton

In 1865, at the 600<sup>th</sup> anniversary of Dante's birth, the municipality of Ravenna decided to carry out a

restructuration of the tomb, and so it was on June 23<sup>rd</sup> that the unexpected discovery of Dante Alighieri's bones took place when some workers, after removing the bricks, found out the fir, wood box bearing the writings left by Friar Antonio Santi and containing Dante's skeleton.

Afterwards, the Municipal Council entrusted two scientists, Professor Puglioli and Professor Bertozzi, with the task of cataloguing and analyzing the bones in a very short period of time, so as to be able to exhibit them to the public on the 25<sup>th</sup> and 26<sup>th</sup> of June, for the celebration of Dante's 600<sup>th</sup> birthday, before being permanently placed in the urn (5).

According to their description, the skeleton weighed 4.2 kilograms and it was in good condition and almost whole. It included: a skull without the jaw and without teeth, the joide bon, the larynx, cervical, dorsal and lumbar vertebrae except *atlas*, *sacrum* and *coccyx*, the pelvic bones, twenty-three ribs, (missing the last right *spuria*), the *sternum* (divided into two fragments), the clavicles, the shoulder blades, the *humeri*, the *radius bones*, (with the *ulna* absent), some of the hand bones, (one *large bone*, one *trapezium*, one *uncinato* and three *phalanges*), the femurs, the *tibias*, one right *fibula*, the *kneecaps*, and some foot bones, (two heels, one *talus*, three cuneiform, one cuboid, and six phalanges).

The anthropological examination confirmed that the bones all belonged to the same individual, with very strong male characteristics, as evidenced by the shape of the pelvis. The welding of the *xiphoid appendix* to the body of the *sternum* and that of the base of the *coccyx* to the apex of the *sacrum*, as well as the state of fusion of the cranial sutures, was compatible with Dante's age at the time of his death, (aged 56 years). From the physical characteristics of the bones, it was also possible to confirm that these had never been buried, as there were no signs of contact with water and mineral salts.

The length of the skeleton, obtained by arranging the vertebrae in contact with each other in the natural order by means of a metal rod passed into their channel, overlapping the head, leaving the space for the first missing cervical vertebra, and adding the *sacrum*, the *pelvis*, the *femur*, the *tibia*, the *talus* and the heel, was equal to 1.55 meters, which must correspond to about 1.65 to 1.67 meters height in life, considering the absence of the soft parts.

The anthropological examination of the bones focused particularly on the characteristics of the *calvarium*, which was in a good state of conservation, presenting only few parcel fractures, (the right styloid apophysis, lacrimal bones, ethmoid masses, and small wings of the sphenoid), with lack of all teeth, with empty alveoli, with no eruption of the last upper left lateral incisor and the third upper left molar.

To evaluate the capacity of the skull, the Authors used Morton's method (6), which consisted in filling the cranial cavity with rice, and they evaluated a cranial capacity of 1554.3 cm<sup>3</sup> with a brain mass estimated about 1640 grams, clearly higher than the average values for male subjects at that time.

The authors also applied the principles of Phrenology to Dante Alighieri's skull, which was a doctrine based on the theories developed by Gall and Spurzheim (7, 8) and scattered throughout Europe and the United States (the major proponent of this theory in Italy was Luigi Ferrarese (9)), even if its scientific groundless was already debated in its time. According to this doctrine, the psychic functions of the individual depended upon the degree of development of particular areas of the brain. Paradoxically enough, during the examination of Dante's skull, Puglioli e Bertozzi found that the areas dedicated to benevolence, veneration, and the thirst for fame and glory were very developed, while the area dedicated to poetic inspiration was poorly developed.

The second examination of Dante Alighieri's skeleton was carried out in 1921, shortly after the conclusion of the celebrations for the 600<sup>th</sup> anniversary of his death, when the Municipal Council of Ravenna assigned to two anthropologists, Professor Fabio Frassetto (from the University of Bologna) and Professor Giuseppe Sergi (from the University of Rome), the task of carrying out, in a very short time (from the 29<sup>th</sup> through the 31<sup>st</sup> of October) a second scientific analysis of the poet's human remains (10).

Despite the very short period of time available, the study was particularly meticulous as it was accompanied by photographic images and drawings, and it enabled to collect a large number of anthropometric data (with a total of 297 measurements taken), bringing some small changes with respect to the original analysis of 1865.

The bones were described as having been in a good conservation state and ocher in color, when comparing the alteration of the organic substance of the

bone (ossein), with the lighter shades for the skull and the darker ones for the shoulder blades and the pelvis.

On the basis of the numerous morphological and anthropometric data collected from the skeleton, the scientists established that Dante was of average height (160 cm) and was affected by an accentuated dorsal kyphosis due to severe ankylosing arthrosis and with drooping shoulders, as can be deduced from the small size of the collarbones.

The skull was of a dolichomorphic one, the face being somewhat elongated, orthognathic and characterized by pronounced prognathism. This characteristic was ascertained, even in the absence of the mandible, by the large size of the spinous process of the infratemporal crest, indicative of hypertrophy of the pterygoid muscle. The nasal bones were large, slightly concave in the middle portion and considerably prominent in the frontal plane, giving the nose a very pronounced and right-deviated appearance. The palate was remarkably asymmetrical with anomalous dentition due to the lack of eruption of the left upper lateral incisor and possibly of the right upper third molar.

Sergi and Frassetto also compared Dante's skull capacity, which was 1700 cc, with those of other famous Italian people, and they found that it was equal to those of Volta and Petrarca and larger than those of Foscolo and Raffaello.

Besides, they tried to determine the weight of the brain and calculated that, regardless of the method chosen, as the authors used the Welcker (11), Manouvrier (12) and Bolk (13) method, Dante's brain weighted 1541 g, so they confirmed that it was clearly above average according to the reference parameters of the time (14, 15). More than the absolute weight of the brain, however, the two anthropologists gave importance to the relative weight of the brain, the so-called "*cephalization quotient*".

This quotient indicates the ratio between the absolute weight of the organ and the weight of the body, according to Dubois' formula:  $K = E / P^{0.56}$ , where "E" represents the weight of the brain in grams, "P" represents the body weight in grams, and "K" is the *cephalization coefficient* or "psychic coefficient" used to measure the degree of intelligence of the individual or species considered. Based on their data, Sergi and Frassetto estimated that the Dante's cephalization quotient was 3.25, considerably higher than what would be considered the "best of man", at 2.7.

The anthropometric data were used also to verify the reliability of Dante's actual physiognomy of the numerous Dante effigies, both in pictorial form and in sculpture and funeral masks, selected from the following: the portrait painted in Giotto's fresco in the Bargello palace in Florence (16, 17); the portrait reproduced in the Palatine Code (18); the portrait by Vasari (17), the two most famous funerary masks, the one by Kirkup (19, 20) and the one by Torrigiani (21); and two sculpture busts, the so-called "bust of Naples" and the one sculpted by Vincenzo Vela (4). To make this comparison, the technique of two-dimensional superimposition of the profile of the skull on the face reproduced in the portraits was used according to the methodology put forward by the German anthropologist Hermann Welcker, used for the examination of the skulls attributed to Friedrich Schiller, Immanuel Kant and Raphael.

At the end of these studies, the Authors concluded that none of Dante Alighieri's best-known representations fully conform to the facial morphology, and that only in Giotto's fresco and in the miniature depicted in the Palatine Codex, was Dante's face reproduced with sufficient correspondence of shapes and proportions with respect to the poet's original physiognomy. As for the masks, the Kirkup one seems to be the more faithful of the two, even if the differences between the mask and the cranium led to the categorical exclusion that it had been made directly on the poet's face, as someone had been believed.

The veto imposed in 1921 against any further analysis of Dante's bones will come to an end in 2021, the year in which a new anthropological study has been programmed, in the context of the numerous celebrations organized for the 700<sup>th</sup> anniversary of the death.

Considering the high general media interest about Dante, which will be renewed in 2021, there is the risk that the scientific approach to the study of the Dante's human remains could be partially contaminated by sensationalism, to the detriment of correct methodological standard and to the dismissal of the well-known limitations inherent in paleopathological analysis, as sometimes already happened in previous published studies.

So, to avoid these inconveniences, according to Snody et al (22), the limitations associated with

diagnosing disease in ancient human remains should be clearly acknowledged and discussed. A clear differential diagnostic process with a firm foundation in extant literature should be demonstrated in any future publication based on the knowledge of previous palaeopathological literature and using established diagnostic methodologies and keeping in mind that the ethical issues surrounding retrospective diagnosis need to be carefully considered prior to publication and public engagement, particularly in the case of historical figures.

On the other hand, it is obvious that the current technological resources in paleopathology (much more complex and accurate than previous research based on anthropometric data) should bring significant unpublished information from the analysis of the skeletal remains, particularly investigating about detectable diseases, referring also to the actual cause of death, which the prevailing historical opinion attributes to the malaria that the poet would have contracted on his return journey from Venice, where he had been sent as an ambassador by the Lords of Ravenna, in order to avoid an imminent war with the powerful Venetian Republic. The exact date of his trip is not known as no documentation has been found, but on the basis of the known historical events, it is reasonable to believe that it took place in the last days of August, in the year 1321.

The first scientist to hypothesize that Dante had died from malaria was Doctor Stefano Cavazzuti, who believed that Dante had fallen ill with *paludism*, (another term to refer to malaria), probably in its most aggressive or *pernicious* form (23).

The word malaria is derived from the concept of *mal'aria*, in that it was a disease created by *bad air*. This term was coined in Venice in 1571, but had at that time already been used by a certain Marco Cornaro from Veneto, who in his writings in reference to the Venetian lagoon, had deduced that "bad air" was created by the formation of swamps at the mouth of the rivers that flowed into the Venetian lagoon (24, 25). We now know that the connection between malaria and swamps is clearly linked to the fact that these environments are usually breeding grounds for mosquitoes, which in turn act as vectors in the spread of the human disease.

Malaria is a “parasitosis”, caused by the protozoa of the genus *Plasmodium* (the most dangerous being *P. falciparum*), which is carried by a mosquito of the genus Anopheles. The disease is currently spread to tropical areas of Africa, South America and Asia, while it has now practically disappeared in industrialized countries (26, 27). In Italy it has been steadily disappearing since the 1950s, and the cases of this illness that do occur in our country each year are mainly linked to tourists returning from “malaria heavy” countries, as well as being attributable to immigration from these countries (28).

Malaria is an acute febrile disease. In a non-immune individual, symptoms appear seven days or more, (usually 10 to 15 days) after the infecting mosquito bite. The first symptoms, (fever, headache, chills and vomiting), can be mild and difficult to attribute to malaria, if they are not linked to the patient’s origin. If the disease is not treated within 24 hours, it can progress to a serious, sometimes fatal end. A correlation between the malaria and thalassemia minor, a blood disease due to a genetic mutation that occurred during the Middle Ages is also well known. In this period, the malaria, was widespread in Europe, due to the structural modification of red blood cells induced by thalassemia, which makes it more difficult for *Plasmodium falciparum* to reproduce within the host (29).

Concerning Dante Alighieri, however, it should be highlighted that there is no historical document which confirms the fact that his death was actually due to malaria, so this hypothesis is probably based only on the fact that at any rate, he died a few days after his long journey by land, through the marshes of the Venetian lagoon where the *Plasmodium* was particularly widespread (4).

On the other hand, there are some authors who disagree with this hypothesis. For example, Alberani (30), based on various historical sources, hypothesized the causes of death other than malaria. First, taking up a passage from Giovanni Boccaccio’s “Trattatello in laude di Dante”, he points out that Dante was described with a very dark skin color, which could possibly suggest that he was suffering from Addison’s syndrome, a disease caused by adrenal insufficiency clinically characterized by asthenia, hypotension, depression and reduced immunological defense against infections. He

stressed also the circumstance that Dante was suffering from a severe dorsal kyphosis, and this anatomical condition, in his opinion, could have determined a reduced expansibility of the pulmonary excursions, thus predisposing the poet to easily contract infectious respiratory diseases, which at the time represented a large quote of mortality.

It is likely that the forthcoming scientific analysis of Dante’s bones, conducted via modern technology, will shed new light on the disease that led to his death, considering that recent paleopathological studies showed that the malaria and other infection diseases can be confirmed, or at least, strongly supposed, through immunohistochemical investigations.

For example, Bianucci et al (31) detected *P. falciparum* HRP-II antigen and *Plasmodium spp.* MSP1-19 antigen by RDTs and indirect immunofluorescence in a 15—18 months old infant ancient Egyptian mummy dating to 2820—2630 B.C., suggesting a massive infection from *Plasmodium*. More recently, Fornaciari et al (32) showed the presence of both *P. falciparum* ancient proteins (*P. falciparum* histidine-rich protein 2 and *P. falciparum* lactate dehydrogenase) in the skeletal remains of Francesco I de’ Medici, who died in 1587 at the age of 56 (curiously the same of Dante).

Another example of ancient disease recognition from palaeopathological investigations was carried out by Drancourt et al (33) using the dental pulp on human remains attributed with reasonable probability to Caravaggio’s skeleton. Several hypotheses for Caravaggio’s death were suggested, such as brucellosis, malaria, or sepsis secondary to an infected wound that Caravaggio received during his last fight in Naples. The Authors concluded that Caravaggio died for sepsis from *Staphylococcus aureus*. This hypothesis was confirmed using two methods of DNA detection: a nonspecific metagenomic method and a specific quantitative PCR method targeting *S. aureus*. Additionally, metaproteomic analysis of the teeth also revealed the presence of only *S. aureus* as a pathogen microorganism. In this short review, it is worth mentioning the study of Mallegni and Ceccarelli Lemut on the alleged skeleton of Conte Ugolino (34), which revealed a low concentration of zincous, strontium and magnesium in the cancellous bone compared to that present in the cortical bone, suggesting a very frugal diet in the

last months of life, and in any case almost completely devoid of protein content. This result was in accordance with the historical testimony of his death from starvation in the Muda tower in Pisa, where he was locked up with two sons and two grandsons, even if it's important to keep in mind that age, sex, and, especially, diagenetic processes or post-mortem alterations following death can alter the chemistry of bone tissue in profound ways (35).

In conclusion, despite the high expectations of the results of Dante's skeleton analysis, in accordance with what Snoddy et al pointed out (24), it is important to underline that the objectives of the media and public opinion are not necessarily in line with those of researchers, and that transparent communication with the media can allow researchers to regain a level of control over the general publicity of their research articles, especially when concerning very famous historical people, avoiding easy but dangerous sensationalism.

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