Palaeopathological Investigations in the Mediterranean Basin from Prehistory to the Early Modern Age: A Multidisciplinary Approach

By

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ABSTRACT

This thesis explores the application of a multidisciplinary approach to palaeopathology in order to offer a broader perspective on the antiquity and morphological presentation of pathological conditions in the past of humankind. Besides the traditional application of anatomical and anthropological methods, this work examines the implementation of historical, literary, archival, artistic, numismatic as well as palaeoradiological and isotopic approaches with the aim of presenting an analysis of ancient pathologies in the region of the Mediterranean Basin from Prehistory to the Early Modern Age which does not only take into account the traces of diseases left on human remains but also, despite some understandable limitations, the palaeoepidemiological presentation of these conditions, hence also exploring signs and symptoms of past diseases.

Building on 20th century palaeopathology pioneer Eve Cockburn's suggestion about adopting such a multifaceted and integrated approach, the thesis investigates, through twelve papers, the pathological conditions encountered in the Carthaginian general Hannibal, in king Ariarathes IV of Cappadocia, a case of auricular haematoma sculpted in a Hellenistic representation of an ancient boxer, an instance of poliomyelitis depicted on an ancient Greek vase, the historical presentation and impact of the major epidemics in the history of humankind as well as focusing on the history and evolution of two closely related infectious diseases, chickenpox and shingles.

Moreover, the thesis tries to shed light on the anthropological and palaeopathological conundrum of the skull attributed to the ancient Greek playwright Sophocles, presents the earliest known case of gigantism in the skeletal remains ascribed to the Ancient Egyptian pharaoh Sa-Nakht, adds, through a palaeoradiological approach, fresh evidence on the presence and antiquity of frontal sinus osteoma in ancient Egyptian remains, and describes pathological presentations and anatomical non-metric traits (particularly a case of large bregmatic bone) in skeletons from a Late Roman Sicilian necropolis. Finally, in the last article, the thesis integrates the previously discussed methodologies with the important application of isotopic investigations, especially ^{14}C dating, in order to increase palaeopathology's capacity to reconstruct the historical progression of diseases by offer a detailed chronological framework.

DECLARATION OF AUTHORSHIP

I hereby declare and certify that the present thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma at any university; and that, to the best of my knowledge, it does not contain any material previously published or written by another person except where due reference is made in the text.

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Statement on the peer-review process

All the papers presented in this PhD thesis have been already subjected to the process of peer-review by adequately qualified scholars and approved of by the editors of the scientific journals or edited books in which they are contained, according to their publication standards and the standards of the discipline wherein they are published.

Definition of the material used

The thesis focuses on the ancient human pathologies, detected on ancient human remains or indirect sources such as literary documents, coins or artworks.

Declaration of Ethics

Ethical clearance was either not needed or is declared in every published paper following the legal requirement of the respective country and museum (or owner).

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INTRODUCTION TO THE RESEARCH TOPIC. THE NECESSITY OF A MULTIDISCIPLINARY APPROACH IN PALAEOPATHOLOGICAL STUDIES

Within the broader scientific field of archaeology, since about the 1970s, starting in North America and gradually expanding to the European academic milieu, bioarchaeology has grown significantly in importance owing to its unique capacity to combine anatomico-anthropological data with archaeological ones by studying the vestiges of ancient human remains within the context of archaeological excavations (Knüsel and Schotsmans 2022:7). It is often referred to as 'human bioarchaeology' although it should be noted that, initially, 'bioarchaeology' had a much broader meaning, referring to the study of all *biota* from archaeological contexts just as Graham Clarke defined it in 1972 (Coles and Marciniak 2010:190).

The introduction of this new discipline, stemmed from the much older academic families of anatomy and osteology, and its methods has allowed archaeologists to detect invaluable information on ancient populations' health, lifestyle, dietary habits, migratory patterns, biological attributes (sex and age at death), which made it possible to trace demographic profiles of the populations whose tangible cultural traces (artefacts, cultural landscapes, funerary rituals, architecture) had been traditionally subjected to archaeological investigations (Larsen 2002).

Displaying a particular focus on skeletal remains – after all the most frequently encountered form of human remains excavated in archaeological settings – bioarchaeology's central theme is represented by the analysis of the interaction between individuals' biological features and their reconstructed behaviour, or, in Clark Spencer Larsen's words, *behavioural inference* (Larsen 1999:1–5). It follows that this approach puts much emphasis on the fact that the human skeleton is a dynamic entity and its changing nature reflects both human behaviour and the influence the environment has exerted on it.

The amount of information provided by bioarchaeological studies, both at the individual and population level, has also succeeded in expanding this discipline's traditional audience (archaeologists and biological anthropologists) by reaching the fields of history and economics, to name but a few, with the ultimate realisation, according to John Coatsworth (as quoted by

Larsen), of ‘ “the masses of evidence” provided from bioarchaeological investigations and the important role they play in understanding historical developments’ (Larsen 1999:1–5).

In the context of this attempt to infer behaviour and evaluate the effect of the environment and its factors on individuals, the study of the stressors and the diseases suffered by ancient humans does represent an important sub-addition to the broader research goals of bioarchaeology. Such a focus on diseases gives way to another, more specialised subject: palaeopathology.

It can be defined as a scientific discipline that investigates the antiquity and historical manifestation of diseases (Merriam-Webster.com Dictionary 2022), which was coined for the first time only in 1892 by the American osteologist and ethnographer Robert Wilson Shufeldt (1850-1934) and came to refer to pathological conditions found in extinct or fossil animals (Buikstra et al. 2017). It is different from the history of medicine, which focuses instead on the history and evolution of medical concepts and the medical practice and, in particular, on the ‘development of the prevention and treatment of disease from prehistoric and ancient times to the 21st century’ (Thomson 1998).

In D.J. Ortner’s definition, palaeopathology ‘encompasses the study of disease, both human and nonhuman, in antiquity using a variety of different sources including human mummified and skeletal remains, ancient documents, illustrations from early books, painting and sculpture from the past, and analysis of coprolites’ (Ortner 2003:11; Buikstra 2019:8). This description of the discipline is somewhat close to the one formulated by Eve Cockburn in the 1970s (Cockburn 1973):

> *The word “paleopathology” is considered to cover an area not limited merely to the study of ancient bodies, but encompassing anything that might give evidence of disease in former eras. This includes ancient writings, pots, sculptures, mosaics, paintings, coins, etc*.

It stresses the importance of evaluating the global presentation of a pathological phenomenon in the past not only through the analysis of mortal remains upon which diseases may have left visible traces, but also examining additional, complementary sources of information that can prove helpful in the assessment of a specific nosological phenotype (Rühli et al. 2016).

Most of those past diseases do still affect the human species in the present world, and have been around for a very long time, from obesity-related complications, cardiovascular diseases, and plague.

Some, like cancer, date back to millions of years ago, even preceding the appearance of humankind's ancient ancestors on our planet, as seen in many instances such as benign tumours in ancient fossil fish or marine reptiles (Capasso 2005). Indeed, most tumoural forms have been found in the skeletal record of ancient civilisations such as the ancient Egyptian one, including osteosarcoma, multiple myeloma, osteolytic metastatic carcinoma, mixed metastatic carcinoma, multiple myeloma, osteolitic metastatic carcinoma, nasopharyngeal carcinoma, etc. (Strouhal 1976; Giuffra et al. 2004).

However, there are some notable exceptions such as smallpox, a disease that had a long and most deadly history (Radetsky 1999) before it was officially declared eradicated by the World Health Organization (WHO) in 1980 following a massive vaccination campaign (Henderson 1976; Strassburg 1982) or Acquired Immune Deficiency Syndrome (AIDS) caused by the HIV virus, which did not exist in the distant past, manifested with its first case in the Democratic Republic of Congo in a man who passed away in 1959, and was declared a new disease only in 1981 (De Cock et al. 2011; Kazanjian 2014).

For the very word 'palaeopathology' (also spelt 'paleopathology'), for which a late 19th century origin was also mentioned above, an independent coinage of the term is, however, the one proposed by the great pioneer of the discipline, Sir Marc Armand Ruffer (1859-1917), in his seminal article entitled 'Studies in palæopathology in Egypt', published in 1913 in *The Journal of Pathology and Bacteriology*, in which he recounted that he had invented the word 'palaeopathology' wishing to describe 'the science of the diseases which can be demonstrated in human and animal remains of ancient times' (Ruffer 1913). The coinage was not immediate and Ruffer arrived at it only after years of research and after consulting numerous Greek colleagues and friends, who reassured him of the appropriateness of his lexical choice (Ruffer 1913). This neologism was deemed to be appropriate enough to precisely define 'the science of diseases that can be demonstrated in human remains and ancient animals', thus avoiding any potential confusion with a similarly sounding term, 'paleontology', which is on the contrary the study of extinct species. It must be acknowledged, however, that up to the 1980s the word 'palaeontology' has occasionally been used to indicate palaeopathological matters. An example is Zuckerman's 1984 article 'Palaeontology of smallpox' (Zuckerman 1984).

Nowadays, just as in Ruffer's day, palaeopathology particularly focuses on the study of skeletal (or osteological) material or preserved bodies such as mummies, either artificial, such as the ancient Egyptians ones, or natural, such as the prehistoric 'Iceman' Oetzi (Lynnerup 2007). These sources

represent a unique 'biological archive' whose in-depth analysis can yield an incredibly conspicuous amount of important information about diseases: their origins, clinical impact and historical trends (epidemiology) in ancient times, their causative agents as well as their evolutionary (or Darwinian) aspects. In its early days (end of the 19th and first decades of the 20th centuries), palaeopathology used a predominantly anatomico-morphological approach by highlighting the gross changes left by diseases on ancient human remains. Shortly thereafter these methodologies started to be complemented by radiological (X-ray imaging) and histological (or micro-anatomical) examinations, which greatly improved palaeopathology's capacity to assess the real burden of disease in the past. With reference to the use of X-rays in palaeopathological investigations, it is worth mentioning that, not long after Wilhelm Conrad Roentgen (1845-1923) had discovered them, the German physicist C.G. Walter König (1859-1936) pioneeringly applied them to ancient tissues, including an Egyptian child mummy still enwrapped in its ancient bandages housed in the Museum of Natural History of Senckenberg (Frankfurt). The results of this test were successfully published in 1896 and initiated a close alliance between medical technology and bio-historical studies (Zesch et al. 2016).

Although at the very beginning the focus of such investigations must have been on precious objects embedded within the mummies' bandages, such as amulets, it later emphasised the study of disease. In more recent years, especially from the 1970s, the palaeoradiological analysis of ancient human remains has reached a higher status thanks to the introduction and application of computed tomography (CT)-scan imaging, which offers a higher resolution and greater range of cross-sectional views than standard X-ray imaging and also allows for digital 3D reconstructions (Chhem and Brothwell 2008). All these techniques constitute the so-called 'non-invasive' methodologies, which, so to speak, allow scientists to take a little peep into millenia-old anatomical structures, without having to resort to the old-style autoptic and highly invasive approaches.

The latter are currently understood to be used sparingly since historical human remains are not only biological tissues but also part of a country's heritage, without forgetting their study – no matter how scientifically important and justified – should be performed adhering to the highest standards of integrity and ethics expected of the medical and anthropological professions.

A practical example of the use of non-invasive radiological techniques is offered by the study of cardiovascular diseases, a special pathological category which represents the first cause of death in the Western world today. These became the main object of a large international study known as the 'Horus' study (i.e. named after the ancient Egyptian god of kingship and the sky), which was able to

demonstrate the effects of atherosclerosis on vessels of ancient mummies, including ancient Egyptian, Peruvian and Puebloan (in the arterial vessels of 26/76 ancient Egyptian mummies, and in 47/137 mummies from all over the globe; Thompson et al. 2013; Allam et al. 2014).
An interesting single case is also that of a natural mummy belonging to a North-eastern Italian priest, don Giovanni Arcangeli, who died in 1751, which has made it possible to prove the existence of stroke in ancient human remains. Before this analysis, stroke was known only through literary based on ancient Greek sources sources and no bioarchaeological demonstration had been adduced (Galassi et al. 2017a; Galassi and Varotto 2019).

The mummy of the mid-18th century priest showed a severely contracted left hand (i.e. anatomical evidence), a calcification in his right coronary artery that supplies the right cerebral hemisphere which in turn innervates the left half of the body and a thinning of the cortical layer of bones in the left upper limb (i.e. radiological evidence), and the archival record of a stroke that left him disabled (*ob morbum apopleticum*). The three lines of evidence combined together speak in favour of a clear retrospective diagnosis (Galassi and Varotto 2019).

Furthermore, biomolecular techniques are rapidly emerging. In 1993, when the internationally acclaimed science fiction film *Jurassic Park* was released, very few must have thought it ever possible to retrieve parts of biomolecules from ancient biological remains and to be able reconstruct extremely precious information in the laboratory. While science has not been able to bring dinosaurs back to life yet, it has indeed succedeed in studying the full genomes of ancient pathogens such *Mycobacterium leprae*, *Mycobacterium tuberculosis*, *Yersinia pestis*, respectively the causative agents of leprosy, tuberculosis and plague (Bos et al. 2014; Schuenemann et al. 2018; Spyrou et al. 2019).

This multidisciplinary approach to the study of past populations and diseases has proved instrumental to the understanding of both phenotypic (i.e. how a biological phenomenon or trait actually manifests) and genotypic (i.e. the genetic predisposition to the manifestation of a trait or phenomenon) dimensions of pathological entities. However, the ancient phenotype of diseases cannot be entirely reduced to the traces left by pathologies on bones or soft tisses.

A disease, today as much as in the past, often consists of a rich series of symptoms and signs that are examined by physicians *before* (and often *exclusively without*) any opportunity to demonstrate pathological lesions at the autoptic level, whence they may infer the real nature and burden of the

disease itself. The *autoptic* (from the Greek words αὐτός, 'self' and ὄψις, 'sight', literally 'the act of seeing or examining for oneself', not always and necessarily synonymous with the physical dissection of bodies), or, more generally, *post mortem* examination of human remains is the standard procedure in anthropological and palaeopathological research. When it comes to contemporary patients, however, autopsies are not always performed. They are customary in forensic contexts or, for deaths occurred within a hospital, in the anatomo-pathological setting.

Those previously mentioned symptoms, that is to say how the patients perceives the disease, and those signs, objective elements that can be recorded by physicians, represent the *corpus* of *semiological* observations and are fundamental to establish a correct diagnostic path. Furthermore, it should be added that diseases that may induce comparable lesions at the skeletal or soft tissue levels, may, on the contrary, have – or have had in the past – different semiological characteristics. These considerations allow us to understand why hard biological evidence is of capital importance as much as is the information on symptoms and signs of diseases, today as well as in ancient times.

However, an immediate major problem lies ahead: how can we collect this kind of information, so typical of the patient-physician interaction seen in the medical practice, if we are dealing with often long-deceased individuals? It appears evident that it will never be possible to obtain a level of accuracy and detail for this category of data as contemporary clinical records can have. Nonetheless, the study of ancient historical sources, both literary and artistic, as well as of the massive archives that document past human behaviours and lifeways on this planet can help palaeopathological and bioarchaelogical research find *complementary* evidence which can eventually enrich the overall knowledge of past pathological phenomena.

The use of the adjective 'complementary' is justified by the fact that the information derived by this specific kind of sources, not anatomo-biological in nature, can only complement and corroborate the data obtained through the study of ancient human remains. Whenever possible, this virtuous combination should be sought for and, in the event that a match of different kinds of sources becomes impracticable, a greater degree of caution in the interpretative phase should be used.

The discipline that specifically focuses on this kind of sources is called 'palaeo-pathography' and tends to be classified as a sub-branch of classical palaeopathology. The term is recent, having started to emerge in 2016 (Galassi and Rühli 2016; Rühli et al. 2016) on the basis of previous studies that took into account problems such the importance of focusing on the descriptions of signs and

symptoms of diseases (palaeo-semiology) without venturing too hurriedly into the field of aetiological determination and the production of clear-cut diagnoses in the presence of only one line of evidence (Galassi and Gelsi 2015) an issue that greatly limited the disciplinary impact of older forms of pathography, which used to be disconnected by an integrated approach and would hardly be discussed within the context of palaeopathological data (Muramoto 2014; Larner 2019). Additional considerations and some theoretical guidelines on how to correctly evaluate historical sources were also proposed, within the activities of the *Paleopathology Association* (PPA), particularly stressing the importance of assessing them in their original languages and not simply in translation (Mitchell 2017).

Other researchers may rather opt for other definitions such as 'indirect sources', 'pathography' or, specifically in the case of diagnoses made through artworks 'icono-diagnosis' – a term particularly common in France and, to a lesser extent, Italy), owing to Mirko Drazen Grmek and Danielle Gourevitch's seminal work *Les Maladies dans l'art antique* (Grmek and Gourevitch 1998).

With special reference to artworks, it should be stressed that, although any artistic expression may yield some information of pathological relevance on the portrayed subject (and potentially even on the artists themselves), the best sources of information for any attempt at a retrospective palaeopathological diagnosis are to be found in those forms of art that, for historical and cultural reasons, favoured an anatomically faithful representation of the human body, hence ancient classical art or Renaissance art, most notably Flemish art, which was found to be especially detailed in the portrayal of rheumatological conditions (Dequeker 1991). For other artistic seasons (e.g. Egyptian art) which did not respect bodily proportions, artworks are discovered to be more perilous when having any diagnostic ambition, as the many a contested retrospective diagnosis on the heretic pharaoh Akhenaton, based on his statuary representation, have shown (Habicht 2011; Habicht et al. 2021).

Not all scholars have historically agreed that a palaeopathographical analysis should necessarily aim to complement the palaeopathological approach and are of the opinion that non-biological sources alone can be enough for retrospective diagnostics. This latter view is more common amongst physicians with an interest in medical history or source-based retrospective diagnoses, while the former is more widely accepted by physicians with a palaeopathological background as well as anthropologists and bioarchaeologists. These opposing views have sometimes led to some mutual criticism. In recent years, this has had surprisingly more to do with some alleged academic reciprocal

negligence (i.e. some physicians diagnosing *tout court* without approaching an expert in ancient diseases and some ancient disease specialists not correlating their findings with contemporary clinical knowledge) rather than with actual epistemological points. Indeed, both stances can equally suffer from a lack of rigour and multidisciplinarity, a condition not exclusively pertaining to one of the two mentioned categories.

Despite lexical subtleties, a large community of academics and researchers are scrutinising historical sources in order to collect information about how diseases appeared to be in the past. The case of a mummy showing traces of a paralysis caused by stroke has been mentioned previously. Another interesting example of how historical sources can support a traditional 'anatomical' study is offered by the case of Federico da Montefeltro (1422-1482), Duke of Urbino (buried in the Church of San Bernardino degli Zoccolanti, Urbino, Marche Region, central Italy) (Fornaciari et al. 2018). The duke's skeletals remains, in particular his right first metatarsal bone, showed the typical lesion caused by gouty arthritis, a terrible rheumatological disease once known as the 'patrician malady' and depicted by British caricaturist James Gillray (1757-1815) in 1799 as a monster biting a gentleman's foot. The osteological evidence is matched by the radiological demonstration of the gouty nature of the previously discussed lesion, the mention in the historical sources of a rheumatic disease affecting the duke, and finally by another mention, a hand-written letter sent by the duke himself to his personal physician in which he complains about a terrible pain in his right foot – precisely the anatomical district in which the gouty lesion was detected.

In this thesis, which focuses on a set of cases all located in the area of the Mediterranean Basin, ranging from Prehistory to the Early Modern Era and encompassing numerous chronological phases and societies, this integrated, multi-source, multidisciplinary approach was implemented with the aim to demonstrate the antiquity, morphological presentation and historical impact of diseases, whenever possible also offering a proper historical contextualisation on how the described conditions would be differently interpreted and treated in the past and how medical knowledge has evolved throughout the centuries. In the last paper of the thesis, the discussion on context and combined methodologies will be integrated by a full-length consideration on the importance of isotope-based chronology in determining the antiquity of palaeopathological conditions.

The thesis is arranged as follows:

Part 1 - Literary, Numismatic and Artistic Evidence: investigates the possibility to detect depictions of pathologies in ancient art, as well as numismatic, literary and archival sources, hence assessing this type of 'indirect' information of disease in the past with an approach at the crossroad between medicine and classical studies: PAPERS 1-6.

Part 2 - Anatomical, archival, photographic, artistic and anthropometrical evidence: focuses on the integration of this approach with more direct sources of information such as photographic, morphological and anthropometrical evidence: PAPERS 7, 8.

Part 3 - Anthropological and palaeoradiological evidence: moves on to 'direct', or hard, biological sources of information for palaeopathology studies, namely osteological remains that are investigated by applying anthropological methods complemented by palaeoradiological and isotopic analyses: PAPERS 9-12.

PRESENTATION OF THE PAPERS INCLUDED IN THE THESIS

Part 1 - Literary, Numismatic and Artistic Evidence

PAPER 1: Galassi, F.M. 2018 Did Hannibal really poison himself? In P. Wexler (ed), *Toxicology in Antiquity*, 2nd edition, pp. 327–333. London: Academic Press.

In the first paper presented in this thesis the death of the famous Carthaginian General, Hannibal Barca (247-183/181 BC), is discussed. I am the sole author of this contribution, published as a book chapter in the second edition of the prestigious edited volume *Toxicology in Antiquity* (2018). Hannibal's cause of death is examined by re-analysing the ancient sources that mention it, briefly contextualising them in the times and political perspectives in which they were produced, and contrasting the different accounts in the light modern knowledge

From this cross-examination of the sources, a more reasonable and likely death scenario was identified in the account presented by the Greek-language writer Plutarch, from which it could be understood that poison alone could not be enough to kill Hannibal and that some form of 'assisted suicide', through a slave's help (by means of choking or interrupting blood flow in the cervical region), would be necessary to optimise the little time the Carthaginian still had considering that his enemies were already about to enter his mansion. This type of death also provides an important comparison with the much more recent suicide of German dictator Adolf Hitler in 1945, for whom a combined mechanism of death by gunshot and poison is postulated, as presented in a recent osteological study (Charlier et al. 2018).

Importantly, also in Hitler's case, the time factor was relevant, considering that his bunker was being about to be attacked by the Red Army during the Battle of Berlin in the last phases of World War II. Even more relevantly, in 1945 chemically manufactured toxins (synthetic poisons) were available and would ensure a much more rapid *exitus*, while in the ancient world only natural poisons could be used, hence making the necessity of a physical help to a suicidal act considerably more realistic.

Following the publication of this chapter, I have continued to elaborate on this case, giving a lecture on 7th May 2019 at the 15th-century established Malatestiana Library (Unesco Memory of the World)

in Cesena, northern Italy, together with leading Hannibal expert (Brizzi 2018) and historian Professor Giovanni Brizzi (University of Bologna), together with whom, subsequently, I wrote a popular article on this topic which was published on 20th May 2019 in the cultural section *Lettura* of *Il Corriere della Sera*, Italy's most widely read quality daily newspaper. In the context of these additional examinations of the subject, we also highlighted how the choice of having a slave help Hannibal commit suicide has a solid tradition in the suicides of famous ancient figures, most notably emperor Nero (AD 37-68). I am also currently working on Nero's death, together with a multidisciplinary team of colleagues, although I already published some preliminary considerations on it, particularly on what anatomical region of the emperor's neck the fatal lesion was made (Galassi and Varotto 2018). In the same article, a discussion of some of the findings presented by Charlier et al (2018) about Hitler's death is present, together with an original examination of the German dictator's final neurological disease and attempted therapy.

PAPER 2: Galassi, F.M., F.D. Pate, N. Antunes-Ferreira and E. Varotto 2021 King Ariarathes IV of Cappadocia (220-163 BC)'s impotence in the light of thyroid disease: a multidisciplinary palaeopathological analysis. *Anthropologie (Czech Republic)* 59(1):87–92.

In this paper, which I co-authored as the first author and published in the journal *Anthropologie* (*Czech Republic*), I examine the medical history behind a very important historical character, King Ariarathes IV of Cappadocia (reigned 220–163 BC), of Classical Antiquity. The King ruled over the north-eastern part of Anatolia and was close to the fellow Hellenistic king Antiochus III The Great (242–187 BC), but ultimately supported the Roman Republic following a major defeat at the Battle of Magnesia (190 BC). It is known from historical sources that the king could not produce an offspring and that his wife Antiochis was accused and publicly shamed for not delivering him that.

Following up on a previous exchange on this topic with authors based in Turkey (Tekiner et al. 2015; Galassi and Gelsi 2015), which also highlighted some aforementioned methodological issues, this paper re-examines the case of King Ariarathes through a multidisciplinary perspective, combining literary and historical sources with geographical context (inclusive of contemporary data on iodine deficiency in the regions of modern-day Turkey which historically constituted the kingdom of Cappadocia) and numismatic evidence which shows the king's cervical morphology. This paper

concludes that Ariarathes' impotence can be reasonably attributed to an endocrinological dysfunction, namely thyroid diseases, and attempting to offer a broader perspective, briefly reflects on the historical role of shaming of women in the past for allegedly not being able to carry out their reproductive duties in a male-dominated society.

PAPER 3: Galassi, F.M., G. Spani, E. Armocida and E. Varotto 2020 'Cauliflower ear in a Hellenistic statue from Syracuse, Sicily (3rd century BC): paleopathological identification of an ancient boxer'. In: Spani, G. and E. Varotto (eds). *Malattie e Medicina tra Letteratura, Storia e Antropologia*, pp. 127–138. Holden, Massachusetts: Quod Manet.

In this contribution, on which I am the first author, published in the form of a book chapter in the bilingual (Italian and English) volume *Malattie e Medicina tra Letteratura, Storia e Antropologia* edited by G. Spani and E. Varotto, I examine the importance of artistic representations – in this case statuary – in the study of ancient diseases, particularly those affecting the soft tissues and visible at the cutaneous level.

The paper analyses the unidentified statue's head housed in the 'Paolo Orsi' Museum (Syracuse, Sicily, Italy) and detects the representation of auricular haematoma, also known as the cauliflower ear morphology, a characteristic trait of fighters and boxers from the most ancient times, well-known to contemporary occupational medicine. After a concise recapitulation of the history of this anatomical trait through history, the paper also highlights how, besides using art as an additional source of information to find traces of pathologies in the past, pathological traits themselves can help art historians identify works of art or attribute them to specific characters.

This lesson was first understood by one of art history's founders, Johann Joachim Winckelmann (1717-1768), who, in his work *Storia delle arti del disegno presso gli antichi*, describes Heracles and Pollux as suffering from this peculiar auricular trait, and, in his *Monumenti antichi inediti*, explains how he identified 'Pollux punishing Lynceus' (5th-4th century BC), a bas-relief from the Villa Albani in Rome, precisely because of this auricular trait.

PAPER 4: Varotto, E., V. Nizzo and F.M. Galassi 2019 Poliomyelitis in ancient Greece (5th century BC)? *Neurology* 92(14):678–679.

The fourth article of this selection of contributions was published in 2019 in the journal *Neurology*, (2021 impact factor: 9.901, Q1 quartile), one of the most important publishing venues of the *American Academy of Neurology*. In this paper, I occupy the position of last senior-author (which in biomedical publications, on a par with the first author, is, contribution-wise, the most important position). Co-author of this article is also the classicist Dr Valentino Nizzo, director of the Villa Giulia Museum in Rome , who confirmed that in the 5th century BC representations of anatomical proportions and traits were considerably more realistic than in the previous centuries and can thus be examined, with all due caution, also from a medical-palaeopathological perspective.

In this concise, yet topical paper, I try to reopen the vexed question of the existence of poliomyelitis in the ancient world, which I had already partially dwelled upon in a previous note published in 2017 (Galassi et al. 2017b) in which the difficulties diagnosing the invalidating effects of that infectious viral diseases were highlighted, with particular reference to the case of pharaoh Siptah (19th dynasty), whose atrophic and shortened left leg can alternatively be linked with poliomyelitis or congenital conditions. In this paper, my coauthors and I stressed the importance of non-osteological sources, namely the figurative arts, when assessing the ancient manifestations of poliomyelitis, in that, when art's canons follow a line of adherence to the anatomical truth (*ad verum*), it can yield additional evidence of soft tissue modifications induced by this infectious neurological disease which can ultimately result in an eye-catching disability. This is particularly evident in the case in the representation of Geras, who appears to be what in the contemporary world would be defined a 'polio survivor', hence an individual who has not succumbed to the disease but shows its stigma on his/her body in adult life.

Although artistic representations, as specified in the introduction to this body of papers, should always be examined with a pinch of salt, in the case of poliomyelitis this can be found of substantial help, since the alterations brought about by the disease are not easy to diagnose in osteological remains and it is virtually impossible to retrieve ancient RNA (the poliovirus) due to the fact that this molecule is much more unstable in the environment than its double-helix counterpart, DNA, hence making its preservation for millennia highly improbable.

PAPER 5: Habicht, M.E., F.D. Pate, E. Varotto and F.M. Galassi 2020 Epidemics and pandemics in the history of humankind and how governments dealt with them. A review from the Bronze Age to the Early Modern Age. *Rivista Trimestrale di Scienza dell'Amministrazione* 2:1–32.

In this extensive contribution, on which I am the last, senior author, having done most of the research and writing together with my coauthor Dr Michael E. Habicht (first author), contextually with the outbreak of the COVID-19 pandemic, I use historical sources, matched with data derived from bioarchaeological, palaeopathological, economic, artistic and religious studies, to reassess some of history's most fearsome pandemics from prehistory (such as the Plague of Athens, the Plague of Justinian, the Black Death, etc.) in order to assess the most likely aetiologies for the diseases that caused millions of deaths around the globe.

More importantly, the paper evaluates how governments and institutions, including scientific institutions and thinkers, have faced such a massive health burden throughout history, concluding that the fast and decided implementation of strong preventive measures such as quarantine and lock-down have proved instrumental in saving civilisations and limiting the devastating effects of the said pandemics.

The approach is comparative and analytical and takes modern medical knowledge and the notions of diseases existing in the past into account, noting how they were considerably different from the current ones. This paper was part of series of historico-medical publications issued at the time on the pandemic theme underlining how much can still be learnt from past pandemics and the ways humankind fought against them and examining the subtle interaction between history, ideas, science and politics (Galassi et al. 2021).

PAPER 6: Galassi, F.M., L. Ingaliso, E. Percivaldi and E. Varotto 2021 Chickenpox and shingles: Historical and palæovirological considerations. *Human Evolution* 36(1-2):259–267.

In this paper, authored in the first position and published in the specialised anthropological journal *Human Evolution*, I investigated the history and palaeopathology of chickenpox and shingles, two conditions well-known in modern medicine and paediatrics but less well-characterised in the past.
To achieve this goal several historical sources were perused and analysed in their original languages (e.g. Latin), highlighting how in the past multiple conditions which are known today to be separate clinical entities could be grouped under the same category because of the use of unspecific vocabulary or yet medically imprecise terms. Besides literary sources and religious references, this paper utilises artworks, stressing the importance of anatomical *ex-voto* representations in that they may yield additional information on diseases in the past.

The information retrieved on the antiquity of these infectious diseases, two sides of the same coin, are then matched with knowledge on the evolution of medical theories and therapies developed in more recent times. The contribution ends with a reference to the fact that often in palaeopathological studies the osteological manifestations of these infectious entities are neglected, while, as it is being realised more and more by scientists with reference to smallpox, they could yield additional important information.

Part 2 - Anatomical, photographic, artistic and anthropometrical evidence

PAPER 7: Galassi, F.M., M.E. Habicht, C. Moraes and E. Varotto 2020 'The alleged skull of Sophocles: Anthropological and paleopathological confutation of a 19th century myth'. In: Congiu, M., C. Micciché and S. Modeo (eds.). *Atti del XV Convegno di studi sulla Sicilia antica*, pp. 253–268. Caltanissetta: Edizioni Lussografica.

In this multidisciplinary contribution, penned as the first author and in the form of a book chapter in peer-review conference proceedings (conference held in Caltanissetta, Sicily on 28th March 2020), I reopen the case of the alleged skull attributed to the ancient Greek playwright Sophocles (ca. 496-406 BC), found in Greece in the 19th century and previously studied by the famous German pathologist Rudolf Virchow (1821-1902). By reassessing the excavation reports and Virchow's study, it is concluded that the skull did not belong to Sophocles but to a much younger individual. An analysis of the *causa mortis* based on lesions present in the anatomical drawings is offered and a first-time facial reconstruction is presented.

Additionally, an investigation based on retrieved newspaper articles on the fate of this skull, previously said to have been deposited in Denmark after being exhibited in the United States, shows this pseudo-lay 'relic' to probably have never left America. Finally, and more generally, this contribution reflects on the habitual 19th century tendency to focus on the cranial element of the skull only, due to now long discredited craniological theories, and to attribute anonymous remains to famous historical characters who were known or suspected to have been buried in the proximity of those excavated skeletons (Armocida et al. 2021).

PAPER 8: Galassi, F.M., M. Henneberg, W. de Herder, F. Rühli and M.E. Habicht 2017 Oldest case of gigantism? Assessment of the alleged remains of Sa-Nakht, king of ancient Egypt. *The Lancet Diabetes and Endocrinology* 5(8):580–581 - with online appendix.

This article, on which I am the first author, re-examines the case of the alleged remains of ancient Egyptian pharaoh Sa-Nakht (ca. 2700 BC) in the light of an endocrinological interpretation, namely gigantism (Mammis et al. 2010; de Herder 2016). In this case, use is made of previous scientific documentation, photographic evidence and anthropometric measurements collected in the past to assess the possibility that that individual was pathologically taller than the average for his time. By applying anthropometric formulae, a case for gigantism is made and, by reviewing other cases present in the medical and palaeopathological literature, this is found to be the earliest known case associated with anatomically modern humans.

A full list of methods and tables used is offered in an online appendix, while in the main body of the article a clinical appraisal of the condition experienced by this ancient patient is provided. The article is published in the journal *The Lancet Diabetes and Endocrinology*, one the best and most widely read endocrinological journals.

Part 3 - Anthropological and palaeoradiological evidence

PAPER 9: Galassi, F.M., E. Varotto, D. Angelici, D. Picchi 2020 Further paleoradiological evidence of frontal sinus osteoma in ancient Egypt. *Journal of Craniofacial Surgery* 31(3):604–605.

This paper, which I signed as first author *ex aequo* with my coauthor E. Varotto, analyses an ancient Egyptian skull and demonstrates, through the application of radiological techniques, the presence of a frontal sinus osteoma, a benign neoplasm growing in the pneumatic cavity of the frontal bone.

This discovery is of particular importance, because, while this anatomical district is a relatively ordinary site of occurrence for osteomas in ancient skulls, until recent times no evidence whatsoever for it existed in ancient Egyptian human remains. No direct explanation for this absence was immediate and a potential lack of adequate palaeoradiological investigations performed on the heads of mummies or skeletonised skulls was considered. In 2019 the first ancient Egyptian case associated with a mummy head housed in Neuchâtel, Switzerland was described in an article on which I was the senior author. This report also happens to be the earliest known case in the human species (i.e. in anatomically modern humans) (Seiler et al. 2019).

The case discussed in this thesis and published in the specialised surgical venue *Journal of Craniofacial Surgery*, represents the second oldest instance of frontal sinus osteoma from Ancient Egypt, hence contributing to the enrichment of knowledge on its frequency and presence in that land in the past.

PAPER 10: Galassi, F.M., R. Brancato, M.T. Magro and E. Varotto 2020 Bioarchaeological and paleopathological analysis of a burial from the Late

Roman necropolis of Pianotta di Calatabiano (CT, Sicily). *Studi Romani* 2(1):31–37.

In this paper published in the archaeological venue *Studi Romani*, which I signed as the first author, together with my colleagues I investigate the remains shown to belong to a young adult male individual aged between 20 and 29 years at the time of death.

A full palaeopathological analysis, inclusive of palaeoradiological examinations and isotope tests, is presented demonstrating how he may have experienced anaemia and its consequences, in addition to traumatic lesions occurring *intra vitam*. The skeleton was excavated from the Late Roman necropolis of Pianotta di Calatabiano (Catania, Sicily) and was contextualised with the archaeological information on that site.

PAPER 11: Galassi, F.M., M.T. Magro, R. Brancato, C. Lubritto, M.G. Belcastro, V. Papa and E. Varotto 2021 A case of large bregmatic bone from Late Roman Sicily: Anthropological analysis and historical aspects. *Human Evolution* 36(1-2):279–291.

This contribution, at the border between physical anthropology and palaeopathology, on which I am the first author, presents a rare instance of large bregmatic bone in the skull of an adult male individual retrieved during excavations at the Late Roman site of Pianotta di Calatabiano (Catania), the same archaeological site mentioned in Paper 10. This anatomical variant (or non-metric trait) cannot be defined by itself as a pathological presentation but its comprehensive analysis, involving radiological techniques and X-ray reconstructions, permits the examination of a rare morphology and the evaluation of its relations with the rest of the cranial bones.

In addition, through an extensive literature review (with a special focus on the Latin works of Paracelsus), this paper investigates the history of this supernumerary bone from prehistory in relation to how it was thought in the past to have therapeutical properties against epilepsy.

The research also investigates past anatomical classifications of the bregmatic bone and associates the discovered morphology with only one case present in the literature.

PAPER 12: Galassi, F.M., C. Lubritto, M.T. Magro, R. Brancato, E. Tortorici, P. Errani and E. Varotto 2021 A key role for chronology: contextualising ancient human remains and pathologies spanning thousands of years. *Environmental Archaeology*, 5 pp.
DOI: 10.1080/14614103.2021.1880682.

In this final paper, on which I am the first author, together with my coauthors I examine the importance of implementing a chronological approach to palaeopathological studies, a topic often only marginally examined in other studies or mostly neglected. The article is published in the Q1 journal *Environmental Archaeology* and is partly based on an oral presentation delivered at an international peer-reviewed archaeological conference (Archaeorganics 2019, held at the University of Rome 'La Sapienza', 20th-21st June 2019.).

By reflecting on the role played by isotope analysis, in particular the dating property of ^{14}C studies, my coauthors and I stress the necessity to better contextualise pathologies – and more generally bioarchaeological studies – offering detailed information on the historical period to which the examined cases belonged, both through chronometric dating (i.e. radiocarbon dating) and relative dating (analysis of archaeological stratigraphy and associated material culture). Five bioarchaeological and palaeopathological cases, from Prehistory to the Early Modern Age are discussed.

DISCUSSION

By the name *science*, we indicate 'any system of knowledge that is concerned with the physical world and its phenomena', 'that entails unbiased observations and systematic experimentation […]' and that 'involves a pursuit of knowledge covering general truths or the operations of fundamental laws' (Encyclopaedia Britannica 1998). The shape science can take consists of the various branches and subdivisions through which we catalogue knowledge about the world (e.g. medicine, chemistry, astronomy, etc.) (Encyclopaedia Britannica 1998). However, it should perhaps be underlined that the English word *science* tends to be interpreted as having a less broad meaning and excluding literature and historical studies, while its German counterpart *Wissenschaft* – truer to the meaning of the all-encompassing Latin word *scientia* – includes all major academic specialties and areas of knowledge (Stanford Encyclopedia of Philosophy 2008).

With this last consideration in mind, it is legitimate, even with reference to a field of knowledge that is less widespread and practised in university studies, such as palaeopathology, to wonder whether the integration of different methodologies and approaches might not bring some significant heuristic advantage.

As a matter of fact, too often has a barrier been perceived, or even erected, between disciplines that merely appear to be very distant from one another, while great room for collaborative research could lead to the creation of a higher interpretative platform from which scientists could contemplate and attempt to answer fundamental questions for archaeology and medicine alike: how old are diseases? Where did they originate? How did it evolve until obtaining the form and epidemiology which we face them today? What factors determined such a transformation or preservation through time? How, based on such considerations and discovered facts, could such pathological entities further evolve in the future? What predictive power can be achieved by studying the past of disease?

Such interrogatives urge the establishment of a dialogue between the humanities and the biomedical sciences, although their walking together hand in hand may have stopped some centuries ago, at time in which an encyclopaedic approach to science gave way to the creation of more specialised research fields and very different research methodologies. This has led to some degree of diffidence or lack of productive communication between these two macro-areas of science, often leading to some radical, yet often turning out to be simply more theoretical questions, such as the following:

Are the diseases of known historical characters but a footnote to the final pages of their much richer (politically, historically, militarily, etc.) biographies? And how can literary accounts on their lives be of help to the study of the antiquity of disease?

It should be underlined from the very beginning that, besides an immediate and admissible interest by historians and archaeologists in learning more also about some of the medical aspects pertaining to the historical figures (and, more generally, populations they investigate), famous historical characters of the past are – unfortunately yet undeniably – the very few individuals for whom biographical details of palaeopathological relevance can still be retrieved. This does not apply, for example, to the thousands of anonymous individuals which are constantly excavated during archaeological fieldwork: we can learn a lot about the signs, the traces – even the stigmas – left upon their mortal remains by diseases, but by no means what kind of symptomatology and soft tissue manifestation they experienced *intra vitam*.

Let us consider the following hypothetical scenario. Patient A contracted venereal syphilis in the last years of the 15th century AD and, having seen the disease chronicise to the tertiary stage, dies with some rather pathognomonic skeletal lesions – for the sake of this theoretical example we wish not to elaborate on the pre-Columbian vs Columbian theories on syphilis and as well as on models on the co-evolution of the pathogenic organism and humans, for which see the recent publication by Baker et al. (2020). Patient B lives in the present world, experiences a comparable situation but is unlucky enough not to be able to receive adequate penicillin treatment, which would cure him of the disease before developing the above-mentioned skeletal form of the pathology. Comparing the two individuals' skeletons and their lesions, a scientist studying this infectious disease would be likely induced to believe that, despite a 500-year interval between them, the disease has not changed at all in its presentation. This view is absolutely correct as far as bones are concerned, but profoundly incorrect, or better, too narrow.

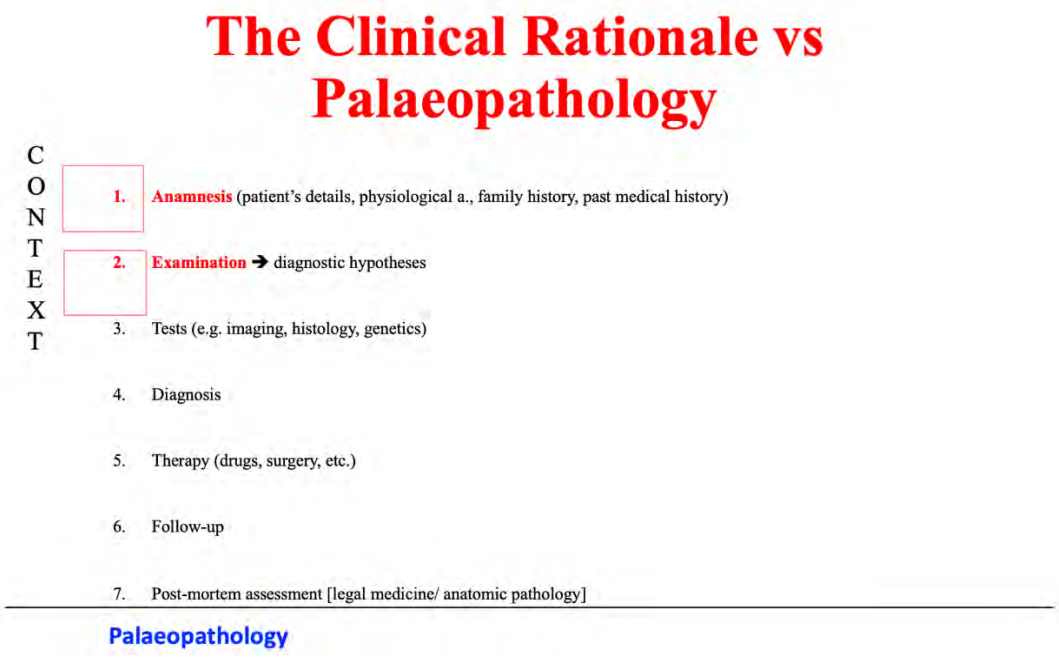
It is indeed through the literary sources that we learn that, from the end of the 15th century to the early decades of the 16th century AD, syphilis gave a major epidemic (by some scholars considered a pandemic in Europe) and it presented with a higher lethality and a much more evident cutaneous manifestation, while, following the accurate description of the Florentine historian Francesco Guicciardini (1483-1540) (Guicciardini 1574:69), we learn that, after some time (approximately 40 years), it became less aggressive and targeted the patients' skin less patently. Such a phenomenon is defined 'pathomorphosis', a clinical transformation of a disease potentially linked with genotypic

changes, which needs to be considered to fully understand the overall impact and evolutionary course of the disease in question.

Yet, historical sources, particularly the biographies of leaders and famous characters of the past, ought to be assessed cautiously, realising that the palaeopathological information contained in them needs to be evaluated in the context of the medical knowledge of the time in which those words were penned and having checked for the exact meaning of those terms in those days.

Let us take examine, for instance, the word *gout*, derived from the Latin word *gutta* meaning 'drop'. In the past gout used to be a rather unspecific term, adopted to describe a series of rheumatic ailments, which would not necessarily be translated with the currently known uric acid-derived pathology (Antonello et al. 2002). This is clearly seen in the aforementioned case of Duke Federico da Montefeltro (1422-1482). When the famous Renaissance warlord and patron of the arts mentioned to his own personal physician that his aching right foot might be caused by gout (*jo credo certamente che la sia gotta*, 'I certainly believe it must be gout'), he was simply saying 'I certainly believe I have some rheumatic disease', hence any straightforward diagnosis should be suspended and the overall context evaluated in detail. Yet, such a prudent step is not suggested by the knowledge of medical matters but by the knowledge of linguistics and philology or by the input provided by an expert in such fields. In Montefeltro's case, in the end, it was really uric acid-caused gout, but this, as previously mentioned, was demonstrated by a combination of multiple analyses and lines of evidence and not only by a single line of attestation, hence excluding of other conditions such as chronic arthritis or rheumatoid arthritis (Fornaciari et al. 2018).

The following diagram, designed by the author of this thesis, shows where the loss of contextual information on the disease suffered by ancient individuals occurs and how detrimental it is to the reconstruction of a palaeopathological phenotype, also highlighting the fact that a palaeopathological study occurs *only after* that loss of information has inevitably happened, thus marking one of the major differences between contemporary medicine and its established clinical diagnostic-therapeutical rationale and retrospective diagnostic approaches. The possibility to retrieve, no matter how rudimentary or fragmentary, traces of pathological descriptions in non-osteological sources can allow scientists to compensate for that lack or loss of information.



The cases examined in the present thesis, combing literary, artistic, numismatic, photographical, archival evidence with more traditional approaches like anthropological analysis, palaeoradiology and isotopic studies have shown how historical descriptions of suicide modality (article on Hannibal of Carthage) or accusation of sterility (analysis of the case of king Ariarathes IV of Cappadocia's wife) can be ruled out in their long-established versions by producing a more compelling, evidence and context-based account; it has demonstrated how ancient artworks can conceal in the correctness of their attention to anatomical details the presence of pathological traits (papers on auricular haematoma and poliomyelitis), as well offer a more comprehensive view on the presentation and impact of epidemic infectious diseases on human societies and civilisations (studies on historical pandemics from prehistory onwards and chickenpox/shingles); it has indicated how combining previous scientific literature with historical and archaeological research and palaeopathological knowledge established fake news such the authenticity of the skull of Sophocles can be discarded, also considering data derived from a pathological assessment of the available evidence, as well as it has proved that a previously published skeleton from ancient Egypt was in fact history's earliest known giants, hence adding new information on the antiquity and evolution of this endocrinological condition (research on the alleged remains of pharaoh Sa-Nakht); it has confirmed and increased existing knowledge on a benign tumoural condition such as frontal sinus osteoma in Ancient Egypt adopting a palaeoradiological approach, which has also been implemented, together with classical anthropological and bioarchaeological methods, to investigate the health status of a Roman-era Sicilian skeleton, highlighting an important anatomical variant in his skull (studies on the Roman skeleton from Pianotta di Calatabiano with in-depth discussion on the bregmatic bone); it has made

a case for the systematic introduction of a chronological approach, combining relative and absolute dating, in order to increase our knowledge of context for ancient human remains and the diseases they present (paper on the role of chronology in palaeopathology).

Moreover, in addition to the individual results for each study, this thesis's aim has been to demonstrate how only through of a combination of methodologies, both pertaining to the biomedical field and the humanities, can a precise and balanced assessment of ancient diseases bring substantial additions to the ongoing debate in the fields of archaeology and anthropology.

CONCLUSIONS

Palaeopathological research is found to be greatly enhanced in its capacity to describe the antiquity and presentation of diseases by combining different methodologies and lines of evidence as preliminarly suggested by its pioneers in the 1970s. Historical, literary, artistic, numismatic, photographic sources, etc. can help scientists achieve a more compelling and comprehensive picture of past pathological conditions and their interaction with human societies.

This integrated approach has been applied to a set of contexts and studies geographically limited to the Mediterrean Basin, its societies and cultural products, but can, with the due skills and a rigorous application of methodologies, be used to investigate other palaeopathological problems from different regions of the globe. A future integration of phenotypic data obtained with such an approach with data derived from palaeogenetic analyses and the gradual application, wherever possible, to a larger population size may yield interesting information on the evolution and manifestation of pathologies throughout time.

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APPENDIX

The appendix lists all publications including their appendices in their original layout as published in various scientific venues.

Please note, however, that for the open access version of the examined thesis, not all the papers originally included can be reproduced entirely here due to existing copyright limitations or embargo.
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For this reason only the first page with title, author information, abstract and/or links to the publishing venues are provided.
The full examined thesis consists of 158 pages.

CHAPTER

22

Did Hannibal Really Poison Himself?

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OUTLINE

References 333

Link to the book chapter: https://www.sciencedirect.com/science/article/pii/B9780128153390000226

ANTHROPOLOGIE

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Special Issue dedicated to the memory of Vladimír Novotný is in preparation.

Abstract

For a long time historical research dismissed the account about King Ariarathes IV of Cappadocia's (reigned 220–163 BC) wife being unable to produce an offspring just as a defamatory explanation concocted by later writers to cover subtler political moves. Having palaeopathologically re-examined the biographical record of King Ariarathes IV in the light of a recently proposed diagnosis of thyroid goiter, by multidisciplinarily combining literary and artistic evidence with biomedical knowledge and rationale, this article proposes an endocrinologically originated sexual dysfunction in King Ariarathes IV and offers a new reading of the subsequent shaming of his spouse.

Keywords

Endocrinology – Thyroid – Sterility – Erectile dysfunction – History of medicine – Palaeopathology

DOI

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CAULIFLOWER EAR IN A HELLENISTIC STATUE FROM SYRACUSE, SICILY (3RD CENTURY BC): PALEOPATHOLOGICAL IDENTIFICATION OF AN ANCIENT BOXER

Francesco M. Galassi, Giovanni Spani,
Emanuele Armocida, Elena Varotto

Auricular hematoma (*otohematoma* or *haematoma auris*) results from a pooling of blood that separates the outer ear's perichondrium from its underlying cartilage. If not promptly corrected with surgery, this lesion leads to devitalization and fibrosis of the cartilage that eventually cause a radical distortion of the ear's anatomy, a condition typically known as "cauliflower ear"[1]. Other designations such as "boxer's ear" or "wrestler's ear" indicate that this alteration is closely associated with traumatic injuries to the ears, particularly common in contact sports. It has been demonstrated that 39-45% of the athletes involved in bodily contact sports show these physical signs[2]. Indeed, cauliflower ears are associated with hearing impairment in wrestlers[3]. The condition can also be idiopathic or related to relapsing polychondritis, leprosy, B-cell chronic lymphocytic leukaemia and ear-piercing practices[4].

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[1] SKIDMORE – GOSSMAN, *Ear, Cauliflower Ear. Treasure Island (FL)*, «StatPearls Publishing», (2018), online at: https://www.ncbi.nlm.nih.gov/books/NBK470424/.

[2] SKIDMORE – GOSSMAN.

[3] Cf. NOORMOHAMMADPOUR et al., *Association Between Hearing Loss and Cauliflower Ear in Wrestlers, a Case Control Study Employing Hearing Tests*, «Asian Journal of Sports Medicine», 6.2 (2015): e25786.

[4] SHILPA et al., *Unilateral Cauliflower Ear Due to Leprosy or Trauma - A Diagnostic Challenge*, «Indian Journal of Leprosy», 88.3 (2016): 189-192; BORGIA et al., *Relapsing Polychondritis: An Updated*

Historically speaking, the exact function of the ear has been the subject of speculation for a long time. A rudimentary understanding was achieved by Aristotle (384-322 BC), who described the ear as an organ of hearing and not of breathing, thus rejecting Alcmaeon of Croton's (*fl*. 5th century BC) assertion that goats breathed with their ears. The Stagirite philosopher was also probably acquainted with what would be renamed the Eustachian tube centuries later, although he failed to grasp its real function. According to Aristotle's observations, the most hidden part of the ear resembled a snail and the bottom was made of a bone that had the same shape as the pavilion, beyond which there was no passage to the brain. Erasistratus (*fl.* ca. 250 BC) and Herophilus (ca. 335 - ca. 280 BC) later started dissecting human corpses and were able to follow the course of the auditory nerve into the brain[5].

From a paleopathological perspective, although several studies have been carried out on ancient Egyptian mummified ears and their external morphology[6], no one has ever detected any definitive biological evidence of the condition, either because of an insufficient preservation of cartilaginous morphologies (including auricular) or, more generally, because the bodies that suffered from this anomaly were not preserved, as embalming practices were extremely rare outside of Egypt during antiquity. Despite such bioarchaeological limitations, paleopathographical soft tissue

Review, «Biomedicines», 6.3 (2018), pii: E84; KINDEM et al., *Bilateral Cauliflower Ear As the Presenting Sign of B-Cell Chronic Lymphocytic Leukemia*, «Journal of Cutaneous Pathology», 41.2 (2014): 73-77; FERNANDEZ et al., *Post-Piercing Perichondritis*, «Brazilian Journal of Otorhinolaryngology», 74.6 (2008): 933-937.

[5] GUERRIER – MOUNIER, *Storia delle malattie dell'orecchio del naso e della gola*, Vol. 1. Milano: Ediemme, 1989.

[6] MUDRY – PIRSIG, *Otology and Paleopathology in Ancient Egypt*, «The Mediterranean Journal of Otology», 3 (2007): 22-30.

analysis in realistic ancient artworks can provide some complementary evidence of pathological traits in the past[7]. To increase existing knowledge on this topic, we analyse in this study the case of a Hellenistic statue (first half of the 3rd century BC) from Akradina (Borgata Santa Lucia, Syracuse) that is held in the "Paolo Orsi" Regional Archaeological Museum of Syracuse (Sicily) and catalogued as *Marble Head of a Man* [Inv. no. 42047] (Fig. 1a). Our analysis consists of archival research enhanced by anatomical and paleopathographical observations.

Neither the sculptor nor the subject has been identified. In the museum's archival records, there is an old-school anthropological note that describes the head as slightly smaller than life-size and of a brachycephalic and oval type, with deep orbits shaded by the high development of the supraorbital margins, and as having a flattened (albeit not fully conserved) nose and curly hair. It also presents poorly preserved ears that may portray an athletic type[8]. Despite the effects of time, the ears suggest that the statue portrays a fighter. While the remains of the left ear show mostly normal physiological proportions (with the apparent exception of the helix and anti-helix), the right ear shows a rather oedematous habitus.

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[7] E.g. cf. MUDRY – PIRSIG; GALASSI – GALASSI, *A Case of Horton's Disease (with Its Potential Neurological Symptoms) Depicted in a Portrait by Andrea Mantegna*, «Neurological Sciences», 37.1 (2016): 147-148; GALASSI et al., *Palaeopathology of the Earlobe Crease (Frank's Sign): New Insights from Renaissance Art*, «International Journal of Cardiology», 236 (2017): 82-84; VAROTTO – BALLESTRIERO, *17th-Century Sculptural Representation of Leprosy in Perugia's Cathedral*, «Infection», 46.6 (2018): 893-895; GALASSI et al., *Poliomyelitis in Ancient Egypt?*, «Neurological Sciences», 38.2 (2017): 375.

[8] Inventory of the "Paolo Orsi" Regional Archaeological Museum [unpublished handwritten document].

Mentions of the cauliflower ear can be found in ancient literary sources such as Aristophanes (ca. 450 – 388 BC) and Plato (428/427 – 348/347 BC)[9], who, in his work *Protagoras*, describes the Spartans as physically different from the other Greeks on account of the morphology of their ears, that is, particularly deformed as a result of their habit of fighting. They are called οἱ μὲν ὦτά τε κατάγνυνται, literally "those who smash their own ears" [Pl. Prt. 342b].

Cauliflower ears have been described in a number of classical Greek and Roman statues now housed in several museums around the world, including the most renowned bilateral representation of the bronze *Boxer at Rest* (Palazzo Massimo, National Museum of Rome, Inv. no. 1055).

Until roughly the first or second century BC, boxers used to wear special hand gear called *caestus* (from Lat. *caedere*: "to cut down" or "to kill") that caused significant trauma to the auricular regions. Made of bull-hide leather filled with metal (the equivalent of modern-day brass knuckles), these *caestus* were used in an ancient sport called *pankration* (literally "all power") that combined wrestling and boxing together. These weighted gloves represented the final evolution of the rudimentary practice of wrapping one's hands with strips of leather before fighting, as can be seen in the *Iliad* when Epeius and Euryalus prepare for a boxing match [23.684]. It has been speculated that the custom of wearing *caestus* gradually declined between the 2nd and 1st centuries BC, as boxing was abolished[10], only to come back again in Europe during the Modern Age[11].

[9] Cf. MUDRY – PIRSIG.

[10] After the reigns of Caligula and Nero, boxing was replaced by other sports.

[11] RODRIGUEZ, *The Regulation of Boxing*, Jefferson, North Carolina & London, McFarland, 2009, p. 24.

To protect their ears and the whole auricular region, ancient boxers would sometimes wear headgear known as *amphotides*, as exhaustively explained by Pierce Egan (1772-1849):

> The amphotides, as the word implies, were a sort of guard to secure the temporal bones and arteries, and encompassing the ears, in their thongs and ligaments, which used to buckle either under the chin or behind the head. They were not unlike caps made of hides of bull, studded with nobs of iron, or strongly quilted, in order to blunt the impetus of the blow; but this mode of fighting seems rather to belong to the second age of pugilistic era[12].

In his *De arte gymnastica* (1569), Girolamo Mercuriale (1530-1606), universally recognized as the father of sports medicine, was the first to collect physiological and pathological aspects of most commonly practiced sports and completed a study on the martial sports of ancient Greece. In chapter VI of his work (*De pugilatus, pancratii, et caestuum facultatibus*), he described boxing, pancratium, the caestus. Within a much broader discussion of traumas suffered by boxers, he also examined injuries to the ears, though without giving any particular details of their morphological aspects ("nocet auribus et pectori")[13].

Bernardino Ramazzini (1633-1714), known mostly for his studies on occupational medicine, dedicates chapter XXXV of his *De morbis artificum diatriba* (1700) to an analysis of several conditions found in athletes (*De athletarum morbis*), including occupational diseases of wrestlers. Although Ramazzini is in many respects more precise and

[12] EGAN, *Boxiana; Or, Sketches of Ancient and Modern Pugilism: From the Championship of Cribb to the Present Time*, Vol. II, London, Sherwood Jones and Co, 1824, pp. 4-5.

[13] MERCURIALIS, *De arte gymnastica*, Venetiis, Apud Iuntas, 1601, pp. 244-249.

accurate than Mercuriale, he nevertheless does not discuss any particular damage to the wrestlers' ears in his work[14].

In the 18th century, the feasibility of an occupational identification of cauliflower ear was first proposed by Johann Joachim Winckelmann (1717-1768) who was not a physician, but an archaeologist and an art historian. In his *Geschichte der Kunst des Alterthums* ("History of Ancient Art"), he indicates that both Heracles and Pollux were affected by this peculiar auricular morphology:

> Solche Ohren hat zum ersten Hercules, weil er in den Spielen, die er selbst dem Pelops des Tantalus Sohns zu Ehren bey Elis anordnete, den Preis als Pancratiast davon trug, wie nicht weniger in den Spielen, die Acastus der Sohn des Peleus zu Argos feyerte. *Ferner ist Pollux mit solchen Ohren* gebildet, weil er den Sieg als Pancratiast erhielt in den ersten pythischen Spielen zu Delphos, und diese Form des Ohrs an einem jungen Helden auf einem großen erhabenen Werke der Villa Albani ist der Grund gewesen, dasselbe auf den Pollux zu deuten, wie ich in meinen Denkmalen des Alterthurms dargethan habe. Man bemerket eben solche Ohren an der Statue des Pollux auf dem Campidoglio und an einer kleinen Figur desselben, in der Farnesina[15].

[14] RAMAZZINI, *De morbis artificum diatriba*, Venetiis, apud J. Corona, 1743, pp. 195-198.

[15] WINCKELMANN, *Geschichte der Kunst des Alterthums*, Wien, Akademischer Verlag, 1776, p. 368. [*Eng*. «In the first place, Hercules had such ears because he won the prize, as Pancratiast, in the games which he himself instituted at Elis, in honor of Pelops, son of Tantalus, as well as in those with Acastus, son of Pelias, celebrated at Argos. In the next place, Pollux is represented with such ears, because he obtained the victory, as Pancratiast, in the first Pythian games at Delphi. In the villa Albani is a large rilievo, on which is the figure of a young hero with an ear of this form, to whom I gave, in consequence, the name of Pollux, and, in my *Ancient Monuments*, I have shown the correctness of the appellation. Such ears may also be observed on the statue of Pollux on the Campidoglio, and on a small

Furthermore, in China, this anomaly was a distinct anatomical marker for opium smokers who would lie on opium beds and rest their heads on hardwood surfaces, a practice first described by Australian-born American film star Errol L.T. Flynn (1909-1959) in 1932 during a visit to Hong Kong, where opiate trafficking and possession would not be made illegal until 1946[16].

The first clear scientific description of auricular hematoma was made by Friedrich Bird (1791-1851) in 1833, but he erroneously considered it to be a feature of mental insanity. Despite incremental improvements in understanding the condition's clinical and physiopathological background, Bird's theory was supported until the beginning of the twentieth century[17].

In 1860, von Gudden clearly explained the traumatic origin of the auricular hematoma[18], but Rudolf Virchow (1821-1902) was the first physician to draw attention to otohematoma after he was able to identify it in a Japanese wrestler[19], a find that was subsequently confirmed by more independent observations in other Japanese wrestlers[20]. Last but not least, in 1905, A. Valentin observed 14 cases of auricular hematoma in the right ears of some Swiss men

figure of the same hero in the Farnesina», translation by G. Henry Lodge, London, George Woodfall and Son, 1850, p. 226].

[16] OWENS – HUMPHRIES, *Cauliflower Ears, Opium, and Errol Flynn*, «British Medical Journal», 297 (1988): 1643-1644.

[17] Cf. MUDRY – PIRSIG. The possibility of the existence of a link between cauliflower ear and psychiatric diseases has been recently resurrected by SINGH et al., *Cauliflower Ear in Late Onset Psychosis*, «Asian Journal of Psychiatry», 39 (2019): 6-7.

[18] VON GUDDEN, *Über die Entstehung der Ohr-Blutgeschwulst*, «Allgemeine Zeitschrift für Psychiatrie», 17 (1860): 121-138.

[19] VIRCHOW, *Pankratiasten-Ohren bei einem japanischen Ringer*, «Virchows Archiv», 101.2 (1885): 387-388.

[20] INTERNATIONAL LABOUR OFFICE, *Encyclopaedia of Hygiene, Pathology, and Social Welfare*, Geneva, 1934, p. 928.

who practiced a traditional type of wrestling called *Schwingen*. Each wrestler would place his right ear against that of his opponent and take hold of the other man's belt or Schwingerhosen (wrestling shorts). The sport's goal was then to knock one's opponent down by kicking his legs out from under him. The vigorous activity could damage both wrestlers' ears, including multiple fractures of the auricular cartilage[21].

Italian anatomical pathologist Attilio Ascarelli (1875-1962), mostly remembered for having identified the victims of the mass killing at the Fosse Ardeatine in Rome (24th March 1944), was the first to associate the deformation of the right auricle not only to people trained in a specific type of wrestling, but to all professional fighters, and eventually considered this kind of defect as an occupational disease. According to Ascarelli, bilateral cauliflower ear was identified as a trait more characteristic of boxers than others. In fact, he believed that such a deformation was caused either by direct violent head trauma or by incidental trauma caused as the two fighters came into close contact with one another[22].

It is curious that around the same time Domenico De Santis, a forensic doctor from Palermo (Sicily), considered the characteristic trait of the Graeco-Roman wrestlers to be auricular hematoma of the left ear, not of the right ear as we have seen above. According to De Santis, the deformation of the left ear was basically caused by two types of grip, which he defined as "cravatta" (the blood choke or sleeper

[21] VALENTIN, *L'othématome de l'oreille droite, speciale aux lutteurs montàgnards suisses*, «La Semaine Medicale», 25 (1905): 357.

[22] ASCARELLI, *L'orecchio dei lottatori e degli acrobati*, «Archivio di Antropologia Criminale Psichiatria e Medicina Legale», 32 (1911): 490; *Contributo allo studio dei caratteri professionali (L'otoematoma dei lottatori e degli acrobati)*, «Il Ramazzini giornale italiano di medicina sociale», 4.1-2 (1912): 94-103.

hold) and "presa di testa a terra" (a choke hold performed against the ground)[23].

It took several decades to recognize the traumatic origin of cauliflower ear and to abandon the psychiatric hypothesis once and for all. Only two years after von Gudden published his work in support of the traumatic origin of this pathology, Alberto Gamba (1822-1901), a physician and a professor of anatomy at the Reale Accademia Albertina (Academy of Fine Arts), published his 1862 descriptive manual of anatomy for his students. In it, he pointed out, like Winckelmann, that damage to the external ear is a peculiar characteristic found in statues of Hercules and wrestlers[24].

In 1896, Samuel Sexton (1833-1896), having visited the Vatican Belvedere during a journey to Italy, described (in the scientific journal *Medical Record*) the monstrous ears of the ancient Greek boxers Creugas and Damoxenos who were immortalized in Canova's neoclassical sculptures[25].

A visual gross anatomical inspection of the Syracusan statue presented here reveals an eye-catching cauliflower morphology of the right ear, with potential lesser involvement of the contralateral ear. Cauliflower auricular morphology involving helix, antihelix and antitragus (Fig. 1b-c) would belong to type IC of the surgical classification suggested by Yotsuyanagi et al.[26] This anomaly is compatible with consistent traumas in the auriculo-temporal re-

[23] DE SANTIS, *Di un segno professionale dei lottatori*, «Archivio di antropologia criminale, psichiatria e medicina legale», 34.3 (1913): 326-330.

[24] GAMBA, *Lezioni di anatomia descrittiva-esterna applicata alle arti belle*, Torino, Tipografia Fratelli Canfari, 1862, p. 279.

[25] SEXTON, *Two Blokes' Ears Seen in the Vatican Belvedere During an Italian Tour*, «Medical Record», 49.16 (1896): 550-551.

[26] YOTSUYANAGI et al., *Surgical Correction of Cauliflower Ear*, «British Journal of Plastic Surgery», 55 (2002): 380-386.

gion, an eventuality also supported by the fact that, in spite of the extensive damage to the nasal region, this area appears to be flattened as the result of traumatic injuries. Both anatomical observations point in the direction of a retrospective occupational diagnosis of a fighter, potentially a boxer, thus corroborating the original archival hypothesis of an athlete.

This discovery from the ancient Corinthian colony of Syracuse enriches the paleopathological and historico-medical record with a new case that further demonstrates how classical art has represented this particular anatomical alteration. Moreover, this paleopathology-based identification once more stresses the importance of a harmonious blending of transdisciplinary approaches in assessing ancient civilizations.

NEUROIMAGES

Poliomyelitis in ancient Greece (5th century BC)?

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Rivista Trimestrale di SCIENZA dell'AMMINISTRAZIONE Studi di teoria e ricerca sociale 2/2020

Epidemics and pandemics in the history of humankind and how governments dealt with them A review from the Bronze Age to the Early Modern Age

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Abstract
This review offers an overview of several devastating historical epidemics and pandemics. The first pandemic ravaging the Middle East and Ancient Egypt was an unidentified "plague" in the late Bronze Age. The plague of Athens was apparently "only" a local epidemic but with fatal consequences for that ancient democracy. Great empires with well-developed trade routes seem to be very susceptible to rapid and devastating spreads as the Antonine Plague, the Plague of Cyprian and the Justinian Plague testify. The great Medieval plague wave in Europe was absolutely devastating, but for the first time it brought along with it substantial containment measures that are still being successfully used today (e.g. isolation, quarantine) as well as the seeds of the development of a new form of medical theory and practice. The blame game that can be observed in the current COVID-19 pandemic has also been seen in previous epidemics and pandemics. Particularly in the case of syphilis, its origin was often attributed to foreign countries. Finally, the paper comparatively stresses the historical importance of an early implementation of a lockdown-based approach as an effective form of controlling epidemic spreads.

Keywords: plague; smallpox; ebola; syphilis; genetics; COVID-19.

Riassunto. *Le epidemie e le pandemie nella storia dell'umanità e la maniera tenuta dai governi nel gestirle. Una review dall'Età del Bronzo alla prima Età moderna*

Questa rassegna offre una panoramica su diverse devastanti epidemie e pandemie nella storia. La prima pandemia che ha devastato il Medio Oriente e l'antico Egitto è stata una "peste" non ancora identificata alla fine dell'Età del Bronzo. La Peste di Atene fu apparentemente "solo" un'epidemia locale, ma con conseguenze fatali per l'antica democrazia. Grandi imperi con vie commerciali ben sviluppate sembrano essere molto suscettibili alla rapida e devastante diffusione epidemica, come testimoniano la Peste Antonina, la Peste di Cipriano e la Peste di Giustiniano. La grande ondata epidemica di peste nell'Europa medievale si è rivelata assolutamente devastante, ma per la prima volta ha portato con sé sostanziali misure di contenimento che ancora oggi vengono utilizzate con successo (ad es. isolamento, quarantena) e lo sviluppo di una nuova forma di teoria e pratica medica. Il gioco dell'incolparsi vicendevolmente che si può osservare nell'attuale pandemia di COVID-19 può, inoltre, essere osservato anche nelle precedenti epidemie e pandemie. In particolare nel caso della sifilide, l'origine del morbo era spesso attribuita a nazioni straniere. L'articolo, infine, sottolinea in maniera comparativa l'importanza storica dell'applicazione precoce di un approccio basato sul confinamento quale forma di efficace forma di controllo delle diffusioni epidemiche.

Parole chiave: peste, vaiolo, ebola, sifilide, genetica, COVID-19

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1. Introduction

Pandemics have long affected humankind and the current outbreak of COVID-19, caused

by the newly emerged SARS-CoV-2 virus, demonstrates that, despite decades of grand scientific and technological advancements, infectious disease pandemics are still accompanying the human species and may well continue to walk alongside it in the future.

During the present COVID-19 crisis, a problematic article by a Swiss historian featured in the widely-read and respected German-language newspaper *Neue Zürcher Zeitung*, in which it was seriously claimed that it is not worthwhile to look at the past in order to learn from it for the present and the future (Reinhardt 2020):

> Jede Zeit ist anders, auch jede Epidemie-Zeit. Gerade deshalb lohnt sich ein Vergleich, nicht, um daraus Lehren zu ziehen, die es wegen der ganz unterschiedlichen Zeitverhältnisse und Zeitbefindlichkeiten nicht geben kann, sondern um nüchtern nebeneinanderzustellen.
>
> Every time is different, even every epidemic time. For this very reason a comparison is worthwhile, not in order to draw lessons from it, which cannot exist because of the very different time relations and the sensibilities of the time, but to soberly juxtapose them (authors' translation)

The author of the article, Prof. Volker Reinhardt, argued that the unique variables associated with each historical pandemic do not allow us to make useful comparisons that can improve our understanding of pandemics as a general concept and, above all, the present one. In fact, his article only focused on the Black Death of the mid-14th century AD but, surprisingly, the author precisely drew the kind of comparisons he had rejected before.

Today we can observe similar egoistic behaviours of the rich and powerful fleeing to the countryside and hiding themselves in their luxury estates in several affluent nations. Following in the footsteps of a novel academic trend of analyzing past pandemics now also reaching out to the popular press (Huber 2020), this article attempts to compare different historical epidemics by highlighting different strategies devised by past government to deal with them (Table 1). To this aim we have selected nine epidemics or pandemics (the Bronze-Age Middle Eastern "plague", the Plague of Athens, the Antonine Plague, the Plague of Cyprian, the Plague of Justinian, the Black Death, the English Sweating Sickness, syphilis and lastly, smallpox outbreaks in the Americas).

Indeed, a closer look at the past and previous epidemics and pandemics shows that

certain strategies for their containment proved successful, while other decisions either proved mostly ineffective or only made those natural catastrophes worse.

2. The "plague" of the Late Bronze Age (14th century BC)

Among the earliest reported epidemics in history is the unidentified plague that hit Ancient Egypt in the Amarna period (late 18th Dynasty, ca. 1325 BC). Earliest hints may be the fact that Pharaoh Amenhotep III had hundreds of statues of the lion-headed goddess Sekhmet made (Sekhmet being thought to bring epidemics but also to remove them from society) (Norrie 2016, 22). Except for one Amarna-letter (EA II) written under his son Akhenaton, which mentions a plague in the time of his father, we have no direct historical evidence for Egypt.

Yet the political situation would fit. After a time of clash between Egypt and its neighbouring states, a time of peace followed with extensive exchange of goods and people. It was suggested that the bubonic plague may have originated in India, spread over to the Middle East, and eventually reached Egypt (Norrie, 2016, p. 23).

The decision of Amenhotep III to relocate his palace to Malqata on the western bank near Thebes, a somewhat isolated location, has been seen by some as a measure taken in the light of a menacing plague, some sort of mitigating attempt by self-isolation. The palace was built from around his eleventh year of reign, followed by a gap of eight years, a period on which there are but limited historical sources (Norrie, 2016, p. 25).

A new epidemic-like outbreak (or a reoccurrence) seems to have taken place in the last years of the reign of Pharaoh Akhenaton. It may be speculated, among other reasons (such as political factors), that Akhenaton felt that the traditional gods of Egypt had failed protecting their own worshippers, hence *de facto* helping him in his goal of promoting a new, henotheistic religion with sun-God Aten at its heart, ultimately replacing the old polytheistic pantheon.

In the time of Amenhotep III or Akhenaton, Deir el-Medina (located on the west bank of

Thebes), the village of the necropolis workmen, was destroyed by a fire. This may have been an accident or, in view of a epidemic, a deliberate attempt of liberating the village from a disease (Norrie, 2016, p. 29).

Not only did numerous inhabitants of the new capital Akhet-Aton seem to have died, but three daughters of Akhenaton and Nefertiti also perished (Neferneferure, Setepenre and Maketaton). Shortly afterwards, the queen mother, Tjye, died, although her mummy shows no clear evidence of such an infectious disease.

After the death of Tutankhamun, the military conflict with the Hittites led to an equally unclear epidemic in the military, which in turn spread to the Hittite Empire. The Hittite king Šuppiluliuma I and his successor Arnuwanda II both died of the disease. The war against Egypt collapsed as a result. Under the next ruler, Muršili II, the plague disappeared. The story of the plague is handed down in literature in the Hittite plague prayers (Kimball and Slocum). However, an exact identification of the disease is not possible. The descriptions are too vague to identify any one particular disease. Diseases of this kind were attributed to the wrath of the gods and the containment measures were therefore meant to appease the gods and consequently did not involve any medical measures. Such a mechanism of human-divine interaction is also typically seen in other cultures and societies, as testified by Apollo's wrath taking the shape of a pestilence in the opening verses of the *Iliad*.

3. The Plague of Athens (430-426 BC)

The disease, known as λοιμός τῶν Ἀθηνῶν, appeared in the second year of the Peloponnesian War between Athens and Sparta and raged devastatingly in Athens. Not only did the epidemic prevent an Athenian victory but, after years of continued war, it led to the ultimate defeat of the ancient "democratic" city against its oligarchic rival Sparta.

A considerable proportion of the population of Athens was killed by the disease (estimated at 75,000-100,000 deaths, Littman, 2009). The flight of the rural inhabitants into the city, protected by the great defensive walls, led to problems of overpopulation and poor

hygiene – an ideal breeding ground for an epidemic. What had originated as a military plan (i.e. the use of a defensive strategy meant to avoid direct confrontation with the Spartan army on Athenian home soil), actually turned into a perfect trap. However, after this devastating outbreak, according to the ancient sources, this seemingly geographically circumscribed epidemic did not evolve into a pandemic and never returned after the war.

3.2 Observations

Thucydides himself doubted the religious explanation, and sought for evidence through observation. The symptoms he described in his masterpiece, *History of the Peloponnesian War*, include fever, redness and inflammation of the eyes, sore throats that led to bleeding and bad breath, sneezing and the loss of voice. He also mentioned that the patients were coughing, vomiting and suffered from extreme thirst. The victims also had pustules and ulcers on the body and suffered from insomnia and diarrhoea. One potentially relevant is the descriptions of hiccups (λύγξ κενή). In addition, the Greek author remarked that

> while the nature of the distemper was such as to baffle all description, and its attacks almost too grievous for human nature to endure, it was still in the following circumstance that its difference from all ordinary disorders was most clearly shown. All the birds and beasts that prey upon human bodies, either abstained from touching them (there were many lying unburied, though), or died after tasting them. In proof of this, it was noticed that this kind of birds actually disappeared; they were not about the bodies, or indeed to be seen at all. But of course the effects which I have mentioned could best be studied in a domestic animal like the dog (Thuc., 2.50).

3.3 Decline of law, religion and desocialization

Thucydides wrote that people stopped caring about the laws because they lived under the death threat of the disease. Honourable behaviour ceased, since people believed that they

would not live much longer anyway.

The Athenians felt abandoned by their gods, since the plague killed without making class or gender distinctions. Piety no longer played a role and the pestilence was seen as a divine sign that the gods supported Sparta, the enemy. An earlier oracle of the god Apollo had predicted that a «Doric (Spartan) war would come and bring a plague» (Thuc., 2.54).

Since those who cared for the sick were most susceptible of infecting themselves, soon many were no longer willing to care for the infected ones. The sick died alone, the dead rotted or were thrown into mass graves. Interestingly, Thucydides was one of the first ancient authors to describe immunity in that he noted that survivors of the first wave developed some protection so that they were safe or only mildly affected by subsequent waves.

3.4 A controversial etiological identification

Based on the described symptoms, it has been speculated that the disease might have been caused by typhoid fever. In 2005, teeth from ancient burials were investigated by Dr Manolis Papagrigorakis's team. They found DNA sequences similar to those of *Salmonella enterica*, the organism causing typhoid fever (Papagrigorakis *et al*., 2005).

The result proved controversial as a second research group found methodological flaws in the Greek study and dismissed the identification (Shapiro *et al*., 2005).

The problem lies in the fact that the technology employed in 2005 (PCR) is prone to contamination, hence producing false-positive results (Campana *et al*., 2014) The burial site was found to be significantly contaminated by animals. Also, the counter-study by Shapiro and colleagues appears to suffers from the same conflicting results as previous studies demonstrated (Boyd and Hartl, 1999). It has been argued that Thucydides, the main historical witness, mentioned that the disease sprang among the caregivers, which is more typical of viral haemorrhagic fever (like ebola or Marburg haemorrhagic fever) than typhoid fever (Qureshi *et al*., 2015).

There is also a linguistic debate whether Thucydides really described the presence of hiccups (λύγξ κενή), a common finding in Ebola (Olson *et al*., 1996; Beeching *et al*., 2014). The ancient Greek has λύγξ κενή, which is either translated as "hiccups" or "ineffectual retching". However, this is a general interpretative problem encountered when analyzing historical reports of physiological and pathological phenomena using a "philologico-clinical" approach (Galassi and Böni *et al*., 2016; Galassi and Bianucci *et al*., 2016).

With a total of about 30 different diseases suggested as the correct interpretation of the Athenian plague (with smallpox and measles being vehemently proposed), this historic scourge has not been really deciphered as far as its etiology is concerned (Papagrigorakis *et al*., 2008).

Known illustrious victims of the disease were Pericles, leading statesman in Athens, and two of his sons.

4. The Antonine Plague

This plague is also known as the Plague of Galen (after the famous physician of the time). It spread across the Roman Empire via the Roman army and the trade routes, both ways that would recur historically as a primary spreading factor, the latter being even more topical nowadays thanks to the shortening of the time required for long-distance travels.

The plague appeared in the east of the Roman Empire in the Roman military, which returned from campaigns against the Parthians. The first cases were reported during the siege of Seleucia (Iraq) in AD 164/65. There are speculations claiming that the plague originally came from China (Han-Dynasty) (De Crespigny, 2007, p. 514).

Smallpox or measles are suspected to have caused the Antonine Plague. The Greek physician Galen left Rome for his native Pergamum in AD 165 to be summoned again in AD 168 to Aquileia, finding himself in Rome in AD 169 where he appointed physician to emperor Marcus Aurelius' heir, Commodus. Galen was an eye-witness of the pestilential outbreak in the Roman army stationed in Aquileia in AD 168/69 and described the

symptoms in his treatise *Methodus Medendi* and in various references found in his writings.

He described the "plague" as great and long-lasting. The patients suffered from fever, diarrhoea, pharyngitis, coughing, vomiting, often accompanied by cutaneous eruptions (dry or pustular) after nine days of illness. Unable to provide his patients with any effective remedies, he sought shelter in Pergamon.

4.2 Unidentified disease

Most scholars tend to prefer smallpox as the most likely disease to explain this plague (McLynn, 2009; Harper, 2017), although no definitive paleopathological and paleomolecular evidence has been provided yet. Evidence for the existence of ancient smallpox may be derived from DNA of the pathogen found in the soft tissues of mummified remains, unfortunately mummies (natural or embalmed corpses) are largely unavailable for this historical period.

4.3 Impact

Many people in despair turned to magic, the later Roman Empire saw a decline of Greek science which was more and more replaced by religion including the rise of Christianity. Reduction of international trade was a long-term result.

The Roman army was hardly able to defend the borders of the empire, and military campaigns, such as the Marcomannic war, had to be postponed. Yet Rome still had the economic assets of its heyday in the 2nd century AD (during the reign of the good emperors of Trajan, Hadrian, Antoninus Pius and Marcus Aurelius). With emperor Commodus and the following Severan dynasty the decline of Rome began.

Other researchers argue for a more direct consequence, as the reduced number of soldiers led to the inflow of Germanic barbarian tribes as buffer dwellers against the immediate

collapse (Sabbatani and Fiorino, 2009; Harper, 2017b).

It is assumed that emperor Lucius Verus died in AD 169 in the village of Altinum on his way to Rome a few days after contracting the disease. Less clear is the case of emperor Marcus Aurelius, who died on 17th March 180 either in Vindobona (Vienna), according to Aurelius Victor, or in Sirmium, according to Tertullian. It is debated among classicists if he died killed by the plague named after him or by cancer.

5. The Plague of Cyprian

This disease is named after Saint Cyprian, bishop of Carthage, an early Christian writer and eye-witness who described the disease. The Roman Empire was struck by this plague during the most delicate "Crisis of the Third Century". It caused a severe weakening of the Roman army desperately trying to defend the borders against migrating barbarians, in order to ameliorate the associated shortage of food caused by the interruption of the production chain.

We have only vague ideas about the nature of this disease, as the historical sources are scarce.

According to them, once again a decline of social cohesion in the population took place. It is said by Pontius of Carthage (Cyprian's biographer) that in AD 250-252 about 5,000 people were dying in Rome each day:

Afterwards there broke out a dreadful plague, and excessive destruction of a hateful disease invaded every house in succession of the trembling populace, carrying off day by day with abrupt attack numberless people, everyone from his own house. All were shuddering, fleeing, shunning the contagion, impiously exposing their own friends, as if with the exclusion of the person who was sure to die of the plague, one could exclude death itself also. There lay about the meanwhile, over the whole city, no longer bodies, but the carcasses of many, and, by the contemplation of a lot which in their turn would be theirs, demanded the pity of the passers-by for themselves. No one regarded anything besides his cruel gains. No one trembled at the remembrance of a similar event. No one did to another what he himself wished to experience (Pontius of

Carthage and Wallis, 1885).

No obvious action was taken by the military emperors of the time, mostly occupied with fending off the invading barbarians. The Christians were regarded as inferior outcasts because of their refusal to make sacrifices for the emperor, therefore insulting the his divine status according to the Roman perspective. It was argued that they avenged themselves with the disease.

5.2 Unidentified disease

Various diseases were suggested to explain this epidemic (Harper, 2017a): Stathakopoulos suggested that both plagues, the Antonine and that of Cyprian, were outbreaks of smallpox (Stathakopoulos, 2004, 95), while Harper argued that the Antonine plague was caused by smallpox and the Plague of Cyprian may have be caused by a haemorrhagic fever (Harper, 2017a).

Only few notable victims are known: Claudius Gothicus (ca. 214-270 AD, Roman emperor from 268 to 270) died of this disease.

6. The Plague of Justinian

The Plague of Justinian is considered by some to be one of the most lethal pandemics, with an estimated death rate of 25 to 50 million victims and a recurrence over two centuries (Floor, 2018, p. 3). According to the so-called maximalist view, the social impact was similar to that seen during the Black Death of the Middle Ages. While the Roman Empire fell in the west in AD 476, the end of classical antiquity for the Eastern Roman Empire started a few decades after the pandemic, around AD 600.

The pandemic, caused by the bacterium *Yersinia pestis*, attacked the Byzantine Empire at

its peak. In the long run, the intended *restitutio imperii* remained incomplete and the decline of the Eastern Roman Empire started some decades later (but it took until almost AD 900 to decline). The plague not only affected the Byzantine Empire but also its rival in the East, the Sassanid Empire (Floor, 2018, p. 3).

The sources must be read critically, as Procopius modelled his report closely following the classic description of a pandemic by Thucydides. The historian Procopius reported the first cases in the port of Pelusium in Egypt. From there, the plague travelled on ships to other parts of the Empire.

This apocalyptic view of the Justinian Plague has been challenged. Mordechai *et al*. argued that the Justinian Plague had a lesser effect on the cultural and political turnover (Mordechai *et al*., 2019): the Roman Empire in the West had disintegrated a century before and the Eastern Roman Empire started to fall not before the 7th century. Only few confirmed cases of victims of the plague are reported archaeologically (ca. 45 cases). The authors argue that minor events like earthquakes and minor volcano eruptions left more traces in historical sources than the plague. Byzantine coinage (gold to bronze coin ratio) does not support a severe economic crisis usually following a devastating pandemic. The amount of papyri produced in Egypt was stable and does not point to an extensive loss of population. The ancient source texts in Egypt do not refer to the plague. As seen in other pandemics, some of the already scarce results were challenged as potential false positives due to outdated PCR technology.

In addition, modern research argues that the disease started much earlier and originated from a different place: in 2013, genetic analyses identified *Yersinia pestis* as the cause of the plague. Ancient strains from the Plague of Justinian and modern strains are closely related to plague samples from Tian Shan, at the borders of Kazakhstan (Eroshenko *et al*., 2017) and China (de Barros Damgaard, Marchi and Willerslev, 2018). This result led to suggestions that the Plague of Justinian may have originated in that region and travelled westwards.

A skeleton found in Tian Shan dating around AD 180 and identified as "early Hun" culture was positively tested for *Yersinia pestis* and is closely related to the basal ancestor of the Justinian plague (de Barros Damgaard, Marchi and Willerslev, 2018). Hence, the disease

existed in central Asia many centuries before the massive outbreak.

The first outbreak in AD 541-542 was extensive in Constantinople and even Emperor Justinian became sick but recovered. In AD 543 the plague arrived in the Sassanid Empire, and also reached Italy and Gaul. From there it sprang over the channel and ravaged extensively in Britain.

In AD 544, emperor Justinian declared the end of the plague. This declaration of victory was premature, as the plague returned again in AD 557 and 570. Until the 770s the plague of Justinian returned locally with a 10-to-25-year recurrence interval.

The last great outbreak was recorded in AD 746-748. The same ideological victory that was pronounced in relation to past epidemics can now be somehow observed in 2020, when China declared the pandemic over and reopened factories (see Blunschi, 2020).

This plague had a major long-term impact on Europe. It hit the Byzantine Empire at its peak, and may have affected its long-term chance to regain the whole territory of the former Roman Empire. Some decades later, the long-lasting decline of the Empire started. A new rising power in the East overran part of the Byzantine Empire and defeated the Sassanid Empire: Islam. Procopius' description of coughing with hemoptysis may point also to pulmonary plague. Another characteristic of the Plague of Justinian was necrosis of the hand.

6.2 Yersinia pestis identified

Recent genetic studies have identified the true cause to be *Yersinia pestis* (plague) and it was also suggested that the Plague of Justinian had its origin in China. The most basal (root) level of strains of *Yersinia pestis* were associated with the Chinese province of Qinghai (Morelli *et al*. 2010). Ancient strains from the Plague of Justinian and modern strains also closely relate to plague samples from Tian Shan, at the borders of Kazakhstan (Eroshenko *et al*., 2017) and China (de Barros Damgaard, Marchi and Willerslev, 2018). This result led to suggestions that the Plague of Justinian may have originated in that region and might have

travelled west. Samples from victims of the Justinian plague found in Germany are matching closely to modern strains from China (Wagner *et al*., 2014). The origin of *Yersinia pestis* can be traced to 3000 BC, as the pathogen's genome was found in skeletons in west and east Eurasia dated back to 3000-800 BC (Rasmsussen *et al*., 2015).

Famous people who suffered from the disease are Emperor Justinian I the Great, although he obviously survived without extensive health consequences, while his rival in the East, the Sassanid Emperor Khosrau I, died of the plague in 579.

7. The Black Death

The definition "Black Death" was not used in the Middle Ages – contemporary chroniclers spoke of the "great dying" or the "great pestilence". "Black Death" ("*Der schwarze Tod*") started to be adopted by Justus Friedrich Karl Hecker (1795-1850) in 1832 (while the second cholera pandemic was taking place) as part of his analysis of the 14th century pestilence.

This plague arrived in Europe in 1346 and, lasting until 1353, was one of the most fatal pandemics ever. According to present knowledge, the disease appeared in central Asia and moved via the Silk Road to the West. Transmitted by rat fleas, it spread over wide parts of Europe. To a certain extent, the plague became endemic in Europe, returning several times in its epidemic form that manifested locally (for instance, later great outbreaks are occurred in Italy 1629-1630, England 1665-1666 and Vienna 1678-1679) but never again so extensive as in the first wave.

7.2 Social impact

The social impact was extensive. In search for a scapegoat, minorities such as the Jewish communities were suspected of having caused the pandemic, one of the accusations being that they had poisoned town wells. In many parts of Europe pogroms of Jews (such as

the Strasbourg massacre, February 1349) and lepers took place, no matter whether such social outcasts were really thought to be responsible for the epidemic outbreak or their enemies simply capitalized on the massive hysteria during those days to liquidate them.

However, there was no lack of people who drew attention to the injustice of these murders. Pope Clement VI (1291-1352), for example, issued a bull prohibiting the persecution of the Jews on 4th July 1348. The papal bull was only effective in Avignon and, unfortunately, contributed relatively little to the protection of the Jews.

Besides these horrific short-term consequences, the plague triggered a lasting change in European society. The extensive population loss literally forced a change in the structure of society. Agricultural workers now had to be better paid and equipped with more rights. England was the first country to abolish serfdom in 1381.

The rise in labour costs led to increasing mechanisation and technology, thus to economic progress. A form of proto-capitalism emerged and resulted in more competition as less manpower was available. Consequently, it became difficult and expensive to continue to have books copied by hand, which in the long run led to the introduction of letterpress printing – an invention that revolutionized the world.

In art, the motif of the Dance of Death (*danse macabre*) and the *triumph of death* emerged, where skeletons perform a dance with each other or with typical representatives of the various feudal estates. Death spared nobody: emperor, king, pope, cardinal, nobleman, noblewoman, peasant, beggar. In Norway, the plague epidemics led to the loss of national autonomy for a long time and the disappearance of the Old Norse language (*Norrønt*).

The plague of the 14th century decisively triggered the Renaissance. People distanced themselves from the ancient medicine based on Galen and new medical research was triggered, as the *ex cathedra* teachings of medieval medicine had proved most ineffective. This paved the way for the early changes ultimately resulting in the long-term development of modern medicine.

7.3 Cultural impact

While most works of art were created after the great plague epidemic, the work of Giovanni Boccaccio stands out as an important literary source. The *Decameron* was written in the years 1350-1353 and describes in the introduction the effects of the plague on the city of Florence (Galassi *et al*., 2018). In the story seven young women and three men flee the plague to live in a country house.

7.4 Mitigating actions

In contrast to previous pandemics, where little coordinated action is known, the plague pandemic saw attempts to contain the disease through action. King Casimir III (1310-1370) immediately closed the borders and Poland was spared.

Local municipal authorities in Milan acted by walling the sick in their houses. The extensive isolation strategy worked (only 10-15% of the population died). As a reaction to the main problems experienced in 1348, the city of Ragusa (modern-day Dubrovnik) introduced in 1377 the "quarantine" (an isolation strategy originally of 30 days, later lasting 40 days, that in those years would be adopted by Venice and other countries). In addition, Venice introduced the *lazzaretti*, a system of locals dedicated to the care of plague patients. Medical actions were also taken by specialist plague doctors tried to protect themselves with the so-called plague masks and also opened the associated ulcers to let the infection run out and reduce the bacterial load of the patients. A prominent role was also played in Italy by institutions known as *Magistrature di Sanità* that dealt with the quality of sold foods, movements of beggars and prostitutes, quality of sold drugs, hygienic conditions of low taverns, etc. including the introduction of a health passport for travellers (Cipolla, 2007).

Nonetheless, fatal errors can be observed in the history of other countries, such as Norway. Though sparsely populated, the disease has spread extensively. The reasons were social interactions with visits, social participation in funerals, distribution of the clothes of

plague-dead people among the heirs and pilgrimages with large masses of people who believed the plague was a punishment of God. No other country had so many recurrences of plague epidemics that occurred every 10-20 years (1360, 1370-1371, 1391-1392, 1500, 1506, 1521, 1525, 1529, 1547-1548, 1565-1567, 1582-1584, 1599-1604, 1619, 1625, 1629, 1636-1639 and 1654). Tax collectors contributed to the spread of the disease, but all fell victim to the disease and tax revenues collapsed in relation to the 1547 epidemic. Only when the plague spread to Denmark (1619) were precautionary measures taken, e.g. the quarantine of people associated with ships, and the isolation of sick people. The royal decree on disease control of 1625 proved revolutionary in that it ordered the use of all public authorities to control the disease and eventually led to the end of the outbreaks of plague in Norway. Actions included the appointment of responsible persons to implement the royal decree, dispatch of doctors, halt of trade and traffic associated with affected places, isolation of the burials of the victims, and finally to prevent the plague from entering at all, the coordinated closure of the borders. In the long run, this approach strengthened the state's power and laid the foundations of the modern state of Norway.

7.5 Yersinia pestis identified

The strain of *Yersinia pestis* causing the Black Death in Europe seems not to be a direct genetic descendant of the Justinian plague strain. However, it is possible that the spread of Justinian plague caused the evolutionary radiation that gave rise to the currently extant 0ANT.1 clade of strains (Bos *et al*., 2011).

The plague claimed many lives, including famous people of the time, e.g. Hans Holbein, painter, who died in London in 1543; Joan of Burgundy, Queen of France, who died in 1348; Joan of England, a daughter of Edward III of England, who died in 1348; Margaret I, Queen of Denmark, Norway and Sweden, who died in Flensburg in 1412; Giorgione, painter, who died in Venice in 1510.

8. The English Sweating Sickness

Also known as *Sudor Anglicus*, this was a mysterious disease that appeared the first time shortly after the battle of Bosworth (first cases after the landing of Henry VII in Milford Haven on 7th August 1485, certain cases are reported before the Battle of Bosworth, which took place on 22nd August 22nd 1485).

Shortly after the arrival of Henry VII in London the new disease broke out extensively and claimed many victims. *Sudor Anglicus* has a quite different etiology and can be clearly distinguished from other infectious diseases. The "English sweating sickness" has a very fast evolvement and is extremely deadly. Swift incubation time led to a quick death (only hours between the first symptoms and death). Typical symptoms are the name giving sweat, feelings of tightness, severe chills, dizziness, headache and pain in the neck, shoulders and limbs, accompanied by severe fatigue. After some hours of a cold stage, the hot phase followed with sweating, fever, headache, delirium, vomiting, tachycardia and great thirst. Complete breakdown and rapid death followed in many cases. Some people developed several fits, as there was no building up of any immunity. Most people who were in contact with sick people also became sick.

8.2 Mysterious disease

The cause of the disease has remained controversial until today. It appeared rapidly, killed quickly and often disappeared after only 2 weeks. The disease returned in 1506, 1517 and again 1528/29 and for the last time in 1551. Then it disappeared from history as quickly as it had appeared. The lethality rate was 30-50%, exact figures of victims are uncertain, typical outbreaks had ca. 40,000 affected people. Summer was the season for *Sudor Anglicus* (opposed to influenza which strikes during the winter) (Heyman, Simons, and Cochez, 2014).

One suggested cause was hantavirus-related pulmonary syndrome. But it is argued that *Sudor Anglicus* was transmitted from human to human, while hantaviruses normally do not spread that way (Bridson, 2001): the disease predominantly attacked males between 15 and 45 years of age. Bridson (2001, p. 1) described the disease as: «The incubation period was frighteningly short and the outcome normally fatal. The symptoms of acute respiratory disease and copious sweating were characteristic, providing the name "the English sweating disease". It was never in the big league of killer epidemics, such as plague and influenza, but its pockets of instant lethality in communities gave it a special ranking of horror. The infective cause of this disease remained a total mystery until it was compared with Hantavirus pulmonary syndrome (HPS) in 1994». To date, a potential rodent carrier for the dissemination of *Sudor Anglicus* has not been established.

The origin of hantavirus is suspected to be in China, the earliest case may date back to AD 900. (Heyman, Simons, and Cochez, 2014). Subsequently, other diseases were taken into account, e.g. bacterial disease (leptospirosis), pulmonary anthrax or a viral disease like a super aggressive form of influenza. To solve the mystery, some researchers suggested the exhumation of known victims. So far it was not possible to determine the exact cause of the disease. As the people died within hours and the disease often suddenly disappeared after two weeks, little is known on mitigating actions. It is reported that the sick people were wrapped in blankets to sweat out the disease according to medieval understanding - which proved fatally wrong in the case of *Sudor Anglicus*.

Some famous patients are reported, among them Queen Anne Boleyn, who survived the disease but not her husband, who had her executed; Arthur, Prince of Wales, died in 1502.

There might be a connection with the outbreaks of the Picardy sweat in France with extensive outbreaks in 1718, 1874, 1906 and 1918 showing similar symptoms.

9. Syphilis

Syphilis or *Lues venerea* (bacterium *Treponema pallidum pallidum*) was also known as

maladie française in the past. The first documented outbreak in Europe was 1494/95 in Naples (Italy) during the French invasion. It was assumed that the French carried the disease to Italy, hence the name *French disease* (Winters, 2006, p. 17). The modern name was coined in 1530 in a poem by the Italian physician Girolamo Fracastoro (ca. 1483-1553) naming it *Syphilis, sive Morbus Gallicus.* The poem tells the story of a sheep herder called Syphilus (derived from σῦς swine and φιλεῖν to love, thus Σύφιλος "swine loving"). Many other names of the disease can be found, either describing the visual appearance (*morbus pustulatus*) or the suspected cause (*lues aphrodisiaca*) or on the suspected country of origin (usually the foreigners – the classic blame game observable in many pandemics) (Adam, 2001).

Although syphilis is more difficult to spread and people can more easily protect themselves against it, it is a pandemic spreading over the world and it remains endemic.

9.2 Description

Syphilis is a chronic infection, transmitted mostly via sexual contact through mucosa1 surfaces and only between humans. It is possible that syphilis is transmitted during pregnancy and during the birth process (*Syphilis connata*). The disease is caused by the bacterium *Treponema pallidum* ssp. pallidum.

Syphilis has many medical appearances, therefore it is tricky to be diagnosed correctly: at the beginning there are often ulcers of the mucosa (painless) and swelling of the lymph nodes. In some cases, the disease evolves into the chronic form, with damages to skin and organs, and in the final stage involves the destruction of the central nervous system. Today, syphilis can be treated with antibiotics (penicillin).

9.3 Past attempts to cure syphilis

Several historical attempts were made to cure syphilis. Until the early 20th century,

treatment with toxic mercury was popular (Caspary, 1887). The side effects were often extensive such as the loss of many or all teeth or the loss of all hair. Mercury also contributed to the extensive shut-down of vital functions of the body. Most extreme treatment even saw the use of mercury(-II)-chloride injected subcutaneously (Stern, 1878).

Native South Americans used a combined therapy of decoctions of wood or bark of the guaiac tree *Guaiacum officinale* and *G. sanctum* (Eppenberger, Galassi, and Rühli, 2017) or sarsaparilla root (*Smilax regelii*) combined with sweat baths and fasting. It is argued that the disease was often less severe among Native Americans than in Europeans, as they appeared to have had no immunisation against syphilis (Harper *et al*., 2008).

The humanist Ulrich von Hutten (died 1523 of syphilis) published on his self-experiment in 1519 *De guajaci medicina et morbo gallico* leading to a temporary improvement of his syphilis. Some potential famous victims of syphilis are Friedrich Nietzsche (1844-1900); Ludwig van Beethoven, lost his hearing and later his life; Catherine II The Great of Russia, as well as Adolf Hitler and Benito Mussolini are suspected to have suffered from syphilis, although there no definitive evidence is available.

9.4 Debated origin

The origin of syphilis is a heatedly debated topic (Baker *et al*., 2020). Dental characteristics suggestive of syphilis patients are proposed as far back as classical antiquity, but also for Byzantine period and medieval England in various sites (Erdal, 2005; Hunnius *et al*., 2006), as well as other pre-Columbian proposed cases (Ioannou, Henneberg, and Henneberg, 2018).

The conclusion of these studies is that congenital syphilis may have existed in Europe before its appearance in the New World, hence challenging the traditional view that syphilis travelled from the Americas to Europe after AD 1492 (Baker *et al*., 2020). Nonetheless, the traditional paleopathological view is still that syphilis came to Europe from the Americas.

10. Smallpox in the Americas

It is generally accepted that European *conquistadores* brought smallpox to the Americas and caused unimaginable epidemics that claimed the lives of millions of Native Americans. Estimated death rates range between one quarter to half of the total population. On the basis of historical documents and archaeological research, it is estimated that up to 90% of the native population became victims of smallpox in the centuries after the arrival of the Europeans (Dobyns, 1983; Thornton, 1990; Verano and Ubelaker, 1992; Warrick, 2003; Halverson, 2006; Tshisuaka, 2007). Smallpox contributed significantly to the destruction of the most sophisticated Meso-American cultures (Maya, Aztecs and others) as well as the fall of South American ones (Inca and others). In some cases, a veritable colonial genocide is suspected (Ostler, 2015). The smallpox epidemic on the Pacific coast of North America from 1775 onwards is scientifically well studied. The European settlers were already well infested with smallpox and therefore largely immunised. The Native Americans of the northwest Pacific coast fell victim to smallpox on a massive scale.

Researchers are debating whether Europeans have used smallpox as a biological weapon. There is evidence from June 1763 that blankets and a handkerchief from the hospital at besieged Fort Pitt were given to a delegation of Native Americans. Smallpox had broken out in the fort. Whether it was intentional or accidental is unclear. The action was unsuccessful, but later an epidemic broke out (Dixon, 2014, p. 154). The accusations of genocide employing smallpox among the Madan people in 1837 was called scientific falsification (Brown, 2005). However, it is striking that there are primarily non-English essays and encyclopaedia entries documenting smallpox epidemics among Native Americans. The 1862 pandemic suggests that at least some immigrants of European origin welcomed the smallpox disaster. This can be deduced from media articles of the time[1].

In addition to the fact that the Native Americans did not have prior natural immunities, the breakdown of food supply intensified the impact of the disease, which led to extremely

[1] See *Index of Historical Victoria Newspapers*, (http://web.uvic.ca/~hist66/vicvic/newspaper/index.php, 23/04/2020).

high mortality rates. The collapse of the social structure also led to high suicide rates. Frequently practiced Native American healing methods such as sweating proved to be counterproductive for smallpox. This lethal mix led to mass suicides among the Cherokee in 1738 and among the Madan in 1837. The indigenous populations burned down infected places and incorporated the disease in their socio-religious system (Kelton, 2004).

First the gods, animal spirits or witchcraft practiced by tribal members were blamed, until they realized the connection with the Europeans. Once accused of spreading the disease, the British and French blamed each other. Halverson (2006, 2020) includes other mitigating actions.

By the early 1700s, Native Americans had begun developing additional methods to prevent infection. Southeastern Native Americans avoided diseased villages and educated others about traveling into infected areas. Another indigenous method to avoid further infection was sending the disease to an enemy via the shaman. The Cherokees performed a Smallpox Dance (the Ahtawhhungnah) in the 1830s to avoid disease, and the Aztecs made a pilgrimage to Popocatépetl to pray to the etsá (smallpox) spirit.

It is estimated that between 80-95% of the Native American population was decimated by diseases introduced by the Europeans conquerors within the first 100-150 years following Columbus's discovery of the New World in 1492, and in some cases such as the Tainos of Hispaniola nearly all of the population succumbed (Cook, 1993; Newson, 2001; Nunn and Qian, 2010). Halverson (2006, 2020) provides the following population loss estimates related to smallpox: 38.5% for the Aztecs 50% for the Piegan, Huron, Cherokee, Iroquois and other peoples; about 66% for the Omaha and Blackfeet peoples, and 90% for the Madan.

11. General observations

The following points become evident when looking at historical and modern epidemics and pandemics:

- the diseases often started in Central Asia or travelled along routes originating in Asia;
- migration and invasions spread diseases, and from a pandemic point of view the migration of people must be seen as a critical mechanism, especially when migrants arrive in great numbers as invaders (e.g. European settlers in the Americas);
- great empires with well-developed trading routes are significantly affected, and in the modern world air travel quickly spreads pandemics over the world;
- times of war and system conflicts (i.e. the confrontation between two rivalling super-powers) contribute to pandemic outbreaks;
- often the nationalistic blame game is played to make sense of the origins and catastrophic impacts of the associated diseases;
- the disaster of a pandemic often leads to the decline of the social structure of a society. Selfish behaviour spreads. Those who help infected people often become victims themselves. If too many caregivers die, there is the danger that everyone runs away and refuses to care for the sick or bury the dead. Under such circumstances anything that previously kept a society together is lost;
- in modern pandemics, depending on the incubation period of the involved diseases, it takes weeks or months until mitigating actions such as isolation and travel restrictions show the desired mitigating effects (Büchenbacher *et al*., 2020).

12. Conclusions

The hermeneutical problems revealed in the Justinian Plague show that a multiperspective approach is definitely important. Today, we observe a primacy of paleogenetics over other disciplines involved in archaeological research since that is perceived as the *non plus ultra* of bioarcheological research due to its hypertechnological nature. Nonetheless we stress how many more approaches and disciplines such as historical sources and economic data derived from numismatic and production of goods can help scientists reconstruct complex and rich phenomena such as past epidemics.

A review of nine historic epidemics and pandemics provides evidence for various mechanisms that have been employed in attempts to counter the associated diseases. The inadequate medical and logistical facilities of the past have often limited the actual efficacy of the said measures in isolating the sick or closing borders. Effective measures that have been employed in pandemics from the past to our time include:

- extensive mitigating actions taken at a very early stage: they were effective in the past and today (Büchenbacher *et al*., 2020);
- being prepared for the return of great epidemics (e.g. Denmark/Norway with their plague legislation or South Korea in the ongoing COVID-19 pandemic);
- almost complete societal lockdown;
- self-isolation of members of populations for periods of several weeks to months to interrupt the transmission of the disease (Milan during the Black Death, Italy, South Korea and Taiwan in 2020);
- closing borders almost immediately, ignoring any multilateral treaties, despite its obvious controversial nature, proves most effective. Poland closed its borders and was mostly spared from the Black Death. To date, this practice also appears to have been effective for Taiwan and Singapore in relation to the 2020 COVID-19 pandemic;
- a centralized government (e.g. Italy, Spain, France) or a powerful presidential system is more capable to act swiftly and comprehensively against an immediate communicable disease threat than federalist countries (e.g. Switzerland, Germany, the USA).

However, a final verdict cannot be made, as the COVID-19 pandemic has but recently begun.

On the other hand, many useless actions associated with epidemics and pandemics are identified at all times and involving many countries:

- denial and cover-up of the disease to prevent an image damage;
- not listening to scientists, including the primacy of political ideology and agenda over common sense and medical counselling;
- spread of false information and misinterpretation of correct information;
- religious explanations for the cause or course of the diseases (the former especially in the past, the latter still seen in some countries, e.g. Indonesia);
- uncoordinated actions by local municipalities or regions, contradicting the overall effectiveness of implemented national or supernational strategies.

Epidemic/ Pandemic	Suspected origin	Most affected country	Disease (and etiology)	Mitigating actions
Late Bronze Age "plague"	Unknown	Hittite empire Egypt	unclear (several hypotheses)	isolation of the ruling class and burning of a village (?)
Plague of Athens	Athens (?)	Athens (Greece)	unclear (several hypotheses)	negligible
Antonine Plague	Asia	Roman Empire	unclear (several hypotheses)	negligible
Plague of Cyprian	Europe?	Roman Empire	unclear (several hypotheses)	negligible
Plague of Justinian	Asia	Byzantine Empire, Sassanid Empire	bubonic plague (*Yersinia pestis*)	negligible (notion of "political end" of an epidemic emerging)
Black Death	China	Europe	Bubonic plague (*Yersinia pestis*)	*lazzaretti*, quarantine, *magistrature di sanità* as a result of the devastating effects of the plague
English Sweating Disease (*Sudor Anglicus*)	England (due to lack of other reports)	England	Leptospirosis / anthrax ?	unknown (mention of medical approaches)
Syphilis	America? Europe?	worldwide	Venereal syphilis	turning point with the introduction

			(*Treponema pallidum*)	of antibiotic therapy
Smallpox in the Americas	Europe	the Americas	Smallpox (variola virus)	unknown, paradoxically potentially favoured by invading Europeans
COVID-19	China (first observed)	worldwide	COVID-19 (SARS-CoV-2)	lockdown, quarantine

Table 1. Overview of selected historical diseases and pandemics from Antiquity to the Modern Era

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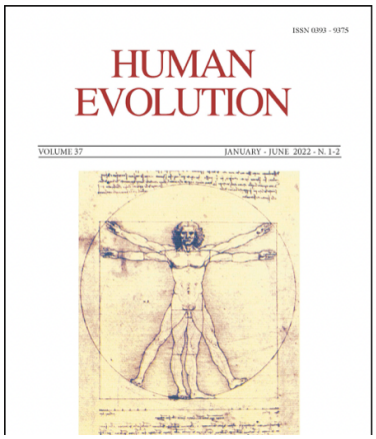
Chickenpox and Shingles: Historical and Palæovirological Considerations



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Abstract

This article summarises the main historical and palæopathological aspects of chickenpox and shingles, two diseases caused by the same pathogen, the varicella zoster virus (VZV). The history of these two diseases is traced back from historical and literary sources, including medical biographies of famous patients of the past (as in the case of Louis XV, King of France), to scientific descriptions of the Modern and Contemporary ages, and also examining votive representations.

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In copertina: Vulci. Particolare di *lekythos* attica a fondo bianco (V sec. a.C.)
con suonatrice di *lyra*, da Archeo 80, 1991

The Alleged Skull of Sophocles: Anthropological and Paleopathological Confutation of a 19th Century Myth

di Francesco M. Galassi, Michael E. Habicht, Cicero Moraes, Elena Varotto[*]

A famous playwright's final years and demise

Sophocles is remembered as one of the greatest poets and playwrights in history. Allegedly the author of over one hundred tragedies, only seven survive to this day. While much has been written and said about his life and literary production, the events characterizing his final years are still nebulous and abundant with anecdotes of rather dubious trustworthiness. One of these is about his being sued by his own son Iophon because he was apparently no longer capable of managing the family fortune due to a supposed dementia.
On this subject Cicero writes:

> Sophocles ad summam senectutem tragoedias fecit; quod propter studium cum rem neglegere familiarem videretur, a filiis in iudicium vocatus est, ut, quem ad modum nostro more male rem gerentibus patribus bonis interdici solet, sic illum quasi desipientem a re familiari removerent iudices. Tum senex dicitur eam fabulam, quam in manibus habebat et proxime scripserat, Oedipum Coloneum, recitasse iudicibus quaesisseque, num illud carmen desipientis videretur. Quo recitato sententiis iudicum est liberatus[1].

[*] F.M.G.: Flinders University and FAPAB Research Center; M.E.H.: Flinders University; C.M.: Arc-Team, Cles-TN, Italy; E.V.: Università degli Studi di Catania, Flinders University and FAPAB Research Center. The researchers would like to express their gratitude to all the colleagues who helped improving this study with their suggestions and bibliographic assistance, in particular Professors Maciej Henneberg (Adelaide, Australia) and Giovanni Spani (Worcester, MA, USA). Last but not least, they express their gratitude to Mr Owen Burke for proofreading this manuscript.

[1] Cic. *De Senectute*, 7.22. The story is found in other ancient sources such as Plutarch, Apuleius, Lucian, etc.

Book chapter part of a book – print edition

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Authors' reply

We appreciate Coen Stehouwer and Thomas van Sloten's comments on the clinical relevance of the endpoints in our meta-analysis of individual participant data from the four large trials of more versus less intensive glucose control in patients with type 2 diabetes. The selection of endpoints followed a rigorous, prespecified process that included foremost: consideration of clinical relevance, use of common definitions, standardised ascertainment, and data availability across the trials.

We agree that some of the components of the composite endpoints such as development of macroalbuminuria and progression of retinopathy are surrogate endpoints that might not always reflect hard outcomes, for which much longer follow-up is usually required. However, we disagree with the premise that these events are not clinically relevant and do not merit consideration.

Screening and surveillance for the development of diabetic nephropathy and retinopathy as well as clinical assessment for development of peripheral neuropathy have long formed the basis of complication screening programmes, worldwide. Evidence of early disease not only provides important prognostic information but prompts the introduction of treatments to minimise disease progression and prevent catastrophic events.[1-3]

The merits of capturing information about the effects of interventions across the disease continuum (early to late stage disease) cannot be overstated. Indeed, if preventive health care is to improve outcomes for all patients with type 2 diabetes, it should not only focus on late stage clinical events but also early clinical events and interventions that reduce disease progression.

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1 Kovesdy CP, Coresh J, Ballew SH, et al, for the CKD Prognosis Consortium. Past decline versus current eGFR and subsequent ESRD risk. *J Am Soc Nephrol* 2016; **27:** 2447–55.

2 James MT, Grams ME, Woodward M, et al, for the CKD Prognosis Consortium. A meta-analysis of the association of estimated GFR, albuminuria, diabetes mellitus, and hypertension with acute kidney injury. *Am J Kidney Dis* 2015; **66:** 602–12.

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See Online for appendix

Oldest case of gigantism? Assessment of the alleged remains of Sa-Nakht, king of ancient Egypt

Gigantism and acromegaly are endocrinological conditions of the greatest antiquity.[1] While mythology and literature abounds with descriptions of giants, the oldest reported palaeopathological cases are remains of a person with acromegaly from 9500 to 11 500 years ago found in New Mexico, USA, and remains of a giant with signs of acromegaly from ancient Egypt (Giza; c 2425 BCE [5th Dynasty]). In 1901, a skeleton was found in the Mastaba K2 tomb near Beit Khallaf, Egypt, which is estimated to date from the 3rd Dynasty (c 2700 BCE).[2,3] The remains are of a very tall man (about 187 cm; figure) and are attributed to King Sa-Nakht, who was an ephemeral king of Egypt during the 3rd Dynasty. It is far from certain whether the remains are really those of King Sa-Nakht, but for the medical assessment of potential gigantism this case has a great value as it could be the oldest known case. The original reports of when the skeleton was found in 1901 gave no definitive diagnosis of either acromegaly or gigantism—both conditions having then already been described in the medical literature—although the case is described several times in general terms in the endocrinological literature.

In the present investigation, we assessed measurements of the skull from previously published articles and reviewed photographs of the skull. We compared these data with two anthropological databases (Howells [1973] and an unpublished database; appendix). We tested several body height formulae on the published long bone data (appendix). All reconstructed heights were *Z* scored against the mean and SD for ancient Egyptian male commoners,[4] and

mean and SD of recumbent body length of male members of the ancient Egyptian royal family.[5] Even though the kings were taller than commoners, the alleged Sa-Nakht is much taller than other royals (average *Z* score 3·5). Only his long bones show signs of exuberant growth (gigantism), while the dimensions of his face do not exceed more than 2 SD (with the exception of the bigonial breadth) compared with other royals (appendix). This finding could indicate an enlargement of the mandible, although other dimensions of the face are not excessively enlarged.

The alleged Sa-Nakht probably had gigantism, truly being the oldest known palaeopathological case in the world. Assessment of the facial structure faintly suggests acromegaly, which could indicate a regression of hyperpituitarism. In ancient times, no surgical or pharmaceutical treatment would be available; therefore, regression could only have resulted from degeneration of the pituitary gland. Infarction, a known clinical phenomenon in the modern world, could have occurred. The fact that he was buried with honours in an elite mastaba-tomb, after reaching adulthood, suggests that gigantism at the time was probably not associated with social margination. While short people were much preferred in ancient Egypt, especially in the early dynastic period, we have no records that very tall people had any special social preference or disadvantage. From all known royal mummies, no other king or queen fulfils the requirement of gigantism. In general, they were taller than commoners, but within the normal range.[5] Inspection of the skeleton's sella turcica and genetic analyses might corroborate the present anthropometric diagnosis.

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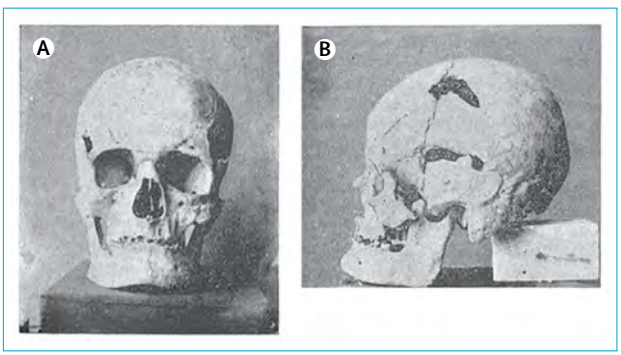

Figure: **The skull attributed to Sa-Nakht, photographed by Garstang in 1903**
(A) Frontal view and (B) lateral view.

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4 Zakrzewski SR. Variation in ancient Egyptian stature and body proportions. *Am J Phys Anthropol* 2003; **121**: 219–29.
5 Habicht ME, Henneberg M, Öhrström LM, Staub K, Rühli FJ. Body height of mummified pharaohs supports historical suggestions of sibling marriages. *Am J Phys Anthropol* 2015; **157:** 519–25.

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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: Galassi FM, Henneberg M, de Herder W, Rühli F, Habicht ME. Oldest case of gigantism? Assessment of the alleged remains of Sa-Nakht, king of ancient Egypt. *Lancet Diabetes Endocrinol* 2017; **5:** 580–81.

Oldest case of gigantism? Assessment of the alleged remains of Sa-Nakht, king of ancient Egypt

Appendix:

I. Additional relevant literature on gigantism and acromegaly:

- For the New Mexico acromegalic cf Brauer J. A case of acromegaly in a prehistoric skeleton from the San Cristobal Ruins, New Mexico. *AJPA* 1991; **34**: 53.
- For the Giza giant cf Mulhern DM. A Probable Case of Gigantism in a Fifth Dynasty Skeleton from theWestern Cemetery at Giza, Egypt. *Int J Osteoarchaeol* 2005; **15**: 261–75.
- For a classic genetic study of mutations in gigantism where the Myers and Garstang re-surfaces, cf. Chahal HS, Stals K, Unterländer M. AIP Mutation in Pituitary Adenomas in the 18th Century and Today. *N Engl J Med* 2011; **356**: 43–50.

II. Literature relevant for the present anthropometric study:

Howell's database cf. Howells WW. Cranial Variations in Man. A Study by Multivariante Analysis of Patters of Differences Among Recent Human Populations. *Pap Peabody Museum Archaeol Ethnol* 1973; **67**.

The body heigh formulae indicated in the table are summarised and tested for their consistency in Sierp I, Henneberg M. Reconstruction of body height from the skeleton: Testing a dozen different methods for consistency of their results. *Anthropol Anzeiger* 2016; **73**: 7–21.

The Institute of Evolutionary Medicine unpublished database used the following published data for the Old Kingdom

- Thomson A, MacIver DR. The ancient races of the Thebaid. being an anthroopmetrical study of the inhabitants of Upper Egypt from the earliest prehistoric times to the Mohammedan conquest based upon the examination of over 1500 crania. Oxford: Clarendon Press, 1905.
- Derry DE. Report on the human remains found by Junker in a cemetery at Turah, Egypt. *Denkschriften der Akad der Wissenschaften Wien Phil -hist Cl* 1912; **56**.

III. The present location of the alleged remains of Sa-Nakht is uncertain.

Table 1a: Sa-Nakht probability of being normal is 0.0035% (using average z-score 2.7)

Table 1b: Compared to the general male population of the Old Kingdom (3rd to 5th Dynasty) for body height and IEM Database for the cranium (Old Kingdom male n=69) [cf. ref. 4 of paper]

Table 1c: The remains of Sa-Nakht were compared with other recorded Egyptian male royals (N=23) [2]

Table 1a			Body height in cm	Z-score Royals [5]	Z-Score commoners [4]
Myers 1901		Original report	187	4.3	5.1
Garstang 1903		Original report	186	4.1	4.7
Pearson 1899	Femur + Tibia	71.272 + 1.159 x (51.1 + 43.15)	180	3.0	3.3
Trotter Gleser 1952/58/77, Black African formula	Femur	2.11 x (51.1) + 70.35	178	2.5	2.6
Breitinger 1937, male formula	Femur	94.31+1.645x51.1	178	2.5	2.6
Breitinger 1937, male formula	Tibia	95.59+1.988x43.15	181	3.2	3.4
Duyar and Pelin 2003	Tall formula. Male. Tibia	1224.15+1.530x431.5=1884.34mm	188	4.6	5.3
		Average	182	3.5	3.9

Table 1b	Femur (mm)	Tibia (mm)	Nose length (mm)	Upper facial height (mm)	Cranial Capacity (CC in ml)	Circumference (mm)
Males	45.2	38.1	52	72.1	1497	No data
Sa-Nakht	51.1	43.2	52	67	1338	547
SD	2.0	1.1	3.40	4.91	116.96	
Z-score	3.0	4.6	-0.01	-1.04	-1.36	

Table 1c	Femur (mm)	Tibia (mm)	CI	Cranial length (mm)	Cranial breadth (mm)	Auricular height (mm)	Nose length (mm)	Upper facial height (mm)	Bizygomatic breadth (mm)	CC (ml)	Circumference (mm)	Bigonial (mm)
Kings of Egypt	45.8	37.8	77.2	188	146	119	57.8	74.2	133.30	1272	538.8	
Sa-Nakht	51.1	43.2	79.3	193	153	118	52	67	122.0	1338	547.0	105
SD	2.0	2.0	4.1	6.19	6.16	5.65	2.35	4.41	4.66	71.59	12.41	2.56
Z-score	2.7	2.7	0.51	0.70	1.12	-0.17	-2.49	-1.63	-2.42	0.91	0.65	2.47

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Further Paleoradiological Evidence of Frontal Sinus Osteoma in Ancient Egypt

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Bioarchaeological and Paleopathological Analysis of a Burial from the Late Roman Necropolis of Pianotta di Calatabiano (CT, Sicily)

Introduction

This contribution focuses on the human osteological remains recovered from a tomb in the necropolis of Contrada Pianotta di Calatabiano (Catania, eastern Sicily). In antiquity, this fertile, water-rich land along the *Via Pompeia* connecting Messina to Syracuse was ideal for intensive agricultural exploitation.

In the 1990s this site was subjected to an early archaeological investigation that brought to light the ruins of the baths of a mid-imperial era-built *villa*, whose stratigraphy dated the ultimate abandonment of the site to theend of the 5th century AD. Between 2014 and 2015 the excavation of the necropolis[1] was carried out in an area that extends immediately north of the mouth of the river Fiumefreddo. The very existence of a monumental necropolis was clarified through the excavation of Trenches 1 and 2 which highlighted that the tombs were aligned and oriented along a north-south axis (fig. 1a). The sepulchral structure demonstrated in Trench 1 is similar to amonumental typology attested in numerous imperial-era suburban contexts in Italy and Sicily[2]: in particular, the building is akin to the type of numerous tombs investigated in 1959 in the northern cemetery of Catania[3]. In Trench 2, the remains of a nucleus made in *opus caementicium* were found: these belonged to a huge build-

[1] In 2014 and 2015, under the scientific leadership of the Superintendency of Catania and in collaboration with the University of Catania. Although numerous studies have been presented on the settlements and prestigious residences that characterized Late Roman Sicily, little is known still about the island's funerary landscape.

[2] R. J. A. Wilson, *Sicily under the Roman Empire*, Warminster 1990; for typologies of funerary Roman monuments vd. H. von Hesberg, *Monumenta. I sepolcri romani e la loro architettura*, Milano 1992, and I. Baldassarre - I. Bragantini - A. M. Dolciotti - C. Morselli - F. Taglietti, *Necropoli di Porto. Isola Sacra*, Roma 1996.

[3] E. Tortorici, *Catania antica. La carta archeologica*, Roma 2016, pp. 42-43; for a description of the podium-type tomb vd. J.M.C. Toynbee, *Death and burial in the Roman world*, Ithaca (N.Y.) 1971, pp. 131-132.

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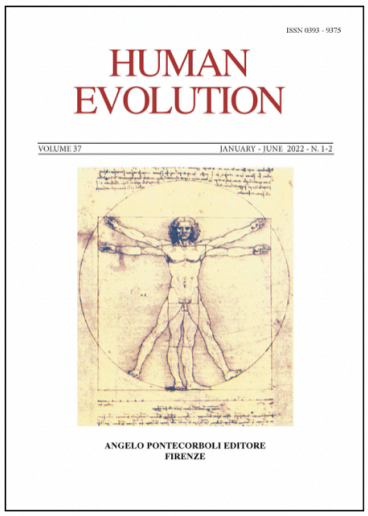
A Case of large bregmatic bone from Late Roman Sicily: anthropological analysis and historical aspects



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Abstract

In this article the authors describe a case of large bregmatic bone found in the skull of a mature adult male individual from the Late Roman necropolis of Pianotta di Calatabiano (Sicily, Italy), radiocarbon-dated to the period 418-536 AD (1s). This Wormian bones was morphologically and radiologically assessed and anthropological measurements were taken in order to describe shape, extent and thickness. This unusual presentation was also contextualised in the broader frame of research on this anatomical variant and an overview of the important role played by this bone in the history of medicine and pharmacy was provided.

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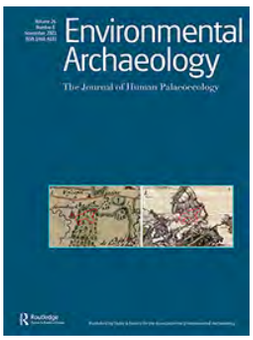

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A Key Role for Chronology: Contextualising Ancient Human Remains and Pathologies Spanning Thousands of Years

Francesco M. Galassi, Carmine Lubritto, Maria Teresa Magro, Rodolfo Brancato, Edoardo Tortorici, Paola Errani & Elena Varotto

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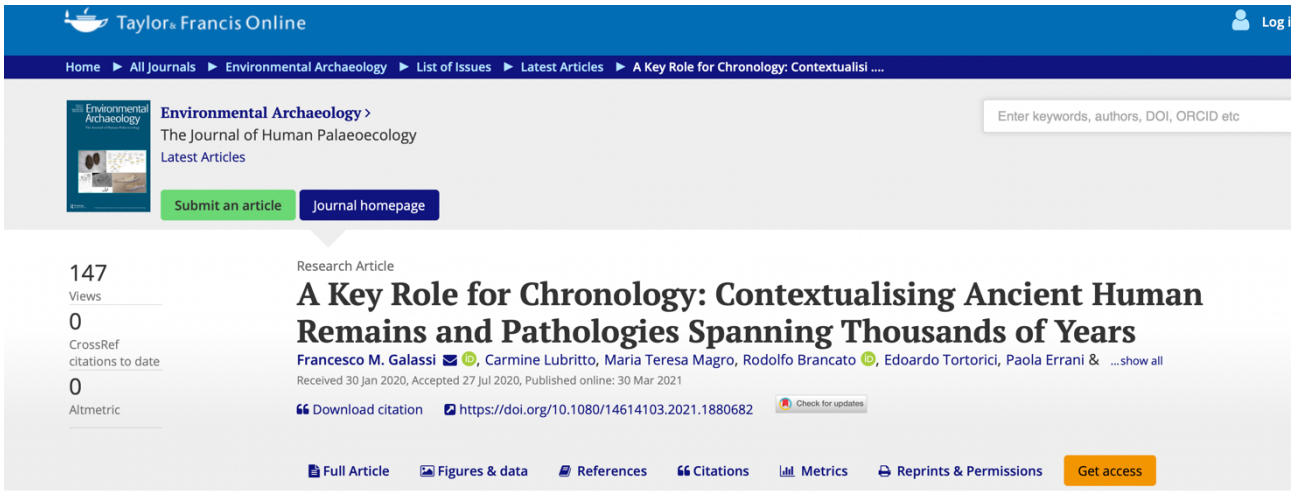

ABSTRACT

In this paper we stress the importance of a chronological approach to bioarchaeological and palaeopathological research, illustrating the key value of correct dating in the reconstruction of the history of diseases and civilisations. With this aim in mind, we present five case studies (from prehistoric times to the late Middle Ages) in which either archaeological or radiocarbon dating proved instrumental in answering research questions ranging from the antiquity of a pathological condition to the identification of historical remains.

KEYWORDS:

- Chronology
- radiocarbon dating
- palaeopathology
- anthropology
- identification
- contextualisation

Link to article: https://www.tandfonline.com/doi/abs/10.1080/14614103.2021.1880682 (published article but still under embargo)