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An Overview of the Evidence of Infectious Disease in Pharaonic Egypt

Lisa Sabbahy Dr.
The American University in Cairo AUC, lsabbahy@aucegypt.edu

Eskiçağda Salgın ve Hastalıklar

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Eskiçağda Salgın ve Hastalıklar

Özlem Sir Gavaz - Gülgüney Masalcı Şahin

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Yayına Hazırlayanlar

Özlem Sir Gavaz - Gülgüney Masalcı Şahin

YAYINLARI

İçindekiler

Önsöz

2020 yılında baş gösteren ve kısa zamanda tüm dünyaya yayılan pandemi süreci, bu kitap projemizin ortaya çıkmasında etkili olmuştur. Günümüzden yaklaşık 4000 yıl öncesinden itibaren yazılı kaynaklar, insanların salgın hastalıklara maruz kaldıklarını, bu salgınlardan korunmak için birçok tedbir ve tedavi yöntemi kullandıklarını göstermektedir. Eskiçağda özellikle Anadolu, Mezopotamya, Mısır ve Ege dünyasını içine alan Yakın Doğu coğrafyasında kaydedilen salgın hastalıklar, devletlerin çöküşünde, göçlerde ve dolayısıyla coğrafyanın sosyo-kültürel yapısının değişiminde önemli rol oynamıştır. Güçlü devletlerin salgınla başa çıkma yöntemleri arasında, en dikkat çekici örnekler arasında temizlik ve karantina uygulamaları bulunmaktadır. Hastalıklarla mücadelede de yine temizliğin, drogların ve majik ritüellerin uygulandığı gözlemlenmektedir. Eskiçağ toplumlarının tedavi yöntemleri incelendiğinde belli bir etkileşim içinde oldukları anlaşılmaktadır. Hastalıklarla mücadele için hekimler, kahinler ve bilginlerin aranılan insanlar olarak ülkeler arası yolculuklar gerçekleştirmeleri söz konusu olmuştur.

Bu kitap projesinin temel amacı, Mezopotamya, Mısır, Anadolu, Ege Dünyası ve Kıta Yunanistan'ı da içine alan coğrafyada, Sumerlerden, Roma Devleti'ne kadar olan tarihsel süreçte, kayıt altına alınan ve insanların kitle ölümlerine yol açan salgın hastalıkların ve bu salgınların yol açtığı politik, sosyal ve ekonomik sorunları ele almaktır. Ayrıca bu kitabın vurgulamak istediği temel nokta, salgınların ve

hastalıkların dünya tarihinde oynadığı değişim sürecini ortaya koyarak, tarihte devletlerin bunlarla başa çıkma konusunda gösterdikleri tecrübe ve çabaların aktarımıyla tarihsel bir farkındalık yaratmaktır.

Öncelikle, "Eskiçağda Salgın ve Hastalıklar" kitabımıza, yazılarıyla katkı veren Türk ve Yabancı bilim insanlarına teşekkür ederiz. Filolojik belgeleri esas alarak hazırladıkları kitap bölümleri, sadece Eskiçağ ve Filoloji alanlarında çalışma yapanlara bir başucu kaynağı olmasından ziyade, aynı zamanda konuya ilgi duyan araştırmacıların da yararlanacağı özgün ve güncel bilgileri içermektedir. Kitabımızda yer alan bölümlerin bilimsel değerlendirmelerinde bizlere katkı sağlayan değerli hocalarımız Prof. Dr. İrfan Albayrak, Prof. Dr. Salih Çeçen, Prof. Dr. Turgut Yiğit, Prof. Dr. Ahmet Ünal ve Dr. Kurtuluş Kıymet'e ayrıca teşekkür ederiz. Kitabımızın yayınlanmasında bize destek olan Ahlatçı Holding Yönetim Kurulu Başkanı Sayın Ahmet Ahlatçı, Holding Genel Müdürlerinden Sayın Kasım Kahraman ve onların şahsında tüm holding çalışanlarına teşekkürü bir borç biliriz. Kitap kapağımızda kullandığımız II. Muršili dönemine ait veba dualarını içeren tablet fotoğrafının temininde bize katkı veren Ankara Anadolu Medeniyetleri Müzesi Müdürlüğüne çok teşekkür ederiz. Son olarak, kitabımızın basımını üstlenen yayınevimiz Ege Yayınları ve Sayın Ahmet Boratav'a da bu süreçteki emekleri ve özverileri için teşekkür ederiz.

Doç. Dr. Özlem Sir Gavaz
Dr. Öğr. Üyesi Gülgüney Masalcı Şahin

Foreword

The pandemic process, which started in 2020 and spread all over the world in a short time, has been effective in the emergence of this book project. Written sources from about 4000 years ago show that people were exposed to epidemic diseases and used many precautions and treatment methods to protect themselves from these epidemics. Epidemics recorded in the Near East geography, which included Anatolia, Mesopotamia, Egypt and the Aegean world in ancient times, played an important role in the collapse of states, migrations and therefore the change of the socio-cultural structure of the geography. Among the methods of coping with the epidemic of powerful states, cleaning and quarantine practices were found among the most remarkable examples. In the fight against diseases, cleaning, drugs and magical rituals were applied. When the treatment methods of ancient societies were examined, it was understood that they were in a certain interaction. In order to combat diseases, physicians, diviners and scholars traveled between countries as key people.

The main purpose of this book project is to deal with the recorded epidemics that cause mass death of people and the political, social and economic problems caused by these epidemics in the geography including Mesopotamia, Egypt, Anatolia, Aegean World and Greece. In addition, the main point that this book wants to emphasize is to create a historical awareness by revealing the change process

that epidemics and diseases have played in the history of the world, by conveying the experiences and efforts of states in dealing with them in history.

First of all, we would like to thank the Turkish and foreign scientists who contributed to our book "Epidemics and Diseases in Ancient Times" with their articles. The book chapters they have prepared on the basis of philological documents will be a reference source for those working in the fields of Ancient History and Philology, and will also contain original and up-to-date information that will benefit researchers who are interested in the subject.

We also thank our esteemed professors Prof. Dr. İrfan Albayrak, Prof. Dr. Salih Çeçen, Prof. Dr. Turgut Yiğit, Prof. Dr. Ahmet Ünal and Dr. Kurtuluş Kıymet who contributed to the scientific evaluation of the chapters in our book. We owe a great debt of gratitude to Ahlatçı Holding Chairman of the Board, Ahmet Ahlatçı, one of the General Managers of the Holding, Kasım Kahraman and all the employees of the holding, who supported us in the publication of our book. We would like to thank the Ankara Anatolian Civilizations Museum Directorate for contributing to the supply of the tablet photograph containing the plague prayers from the Muršili II period, which we used on our book cover. Finally, we would like to thank Zero Books/Ege Yayınları and Ahmet Boratav, who undertook the publication of our book, for their efforts and dedication in this process.

Doç. Dr. Özlem Sir Gavaz
Dr. Öğr. Üyesi Gülgüney Masalcı Şahin

Takdim

İnsanlık, tarih boyunca salgın ve pandemilerin oluşturduğu koşullarla birçok kez sınanmış ve topyekûn ortaya konulan mücadeleler önemli sonuçlar ortaya çıkarmıştı. Böylelikle şehirleşme düzeninden ekonomik altyapılara, siyasi organizasyonlardan yerleşik kültür, nüfus politikaları ve bilimsel araştırmaların yönüne kadar birçok konu başlığında alışkanlıklar yerini yeni durumlara bıraktı.

Bugün baktığımızda, geçmiş tecrübelerden daha yüksek bir etki ile hissettiğimiz pandemi koşulları bambaşka sosyal değişikliklere şimdiden kapı aralamış durumda. Coğrafya, iklim, dil, zaman, ekonomik dilim, siyasal tercih ve hatta bilimsel gelişmişlik dahi fark etmeksizin tüm insanlığı aynı yönde bir araya getiren Covid-19 pandemisinin oluşturacağı değişimler yakın gelecekte daha da açık bir şekilde görülecek.

Hititolog Doç. Dr. Özlem Sir Gavaz ve Hititolog Dr. Öğretim Üyesi Gülgüney Masalcı Şahin editörlüğü ile hayata geçirilen ve Anadolu'nun geçmişine ışık tutan 'Eskiçağda Salgın ve Hastalıklar' eserinde, bilim insanlarımızın, insanlığın bugün yaşadığı felaketlerin bir anlamda geçmişine derinlemesine bir ışık tutarak tahlil, tespit ve tenkitlerine şahit oluyoruz. 4.000 yıl öncesinin salgın şartlarına bilimsel bir yolculuk yaparken, o dönemde alınan tedbirleri, uygulanan karantina yöntemlerini, çözüm arayışlarını, yaşanan kültürel, siyasal, ekonomik ve bilimsel değişimleri görüyoruz.

Ahlatcı Ailesi olarak uluslararası anlamda büyük bir emsal ve referans kabul edilecek olan bu önemli eserin yayınlanmasından son derece memnun ve mutluyuz. Ailemizi teşkil eden tüm iştirak ve çalışma arkadaşlarımız ile birlikte akademik manada gerçekleştirilen tarih araştırmalarını her daim desteklemeye devam ederken, insanlığın ortak sorunu haline gelen konular üzerinde yüksek teknoloji araştırma ve geliştirme çalışmalarımızı sürdürüyoruz. Pandemi ile mücadelede geçmiş tecrübeleri etüt ediyor, bugünün ve geleceğin ihtiyaçlarına cevaplar üretmeye çalışıyoruz.

Bu kapsamda dünyada ilk defa mevcut geleneksel mRNA temelli aşılardan farklı olarak protein temelli nazal bir yöntemle uygulanan yerli Covid-19 aşı çalışmalarımız tüm hızıyla sürdürülüyor. Aşı çalışmalarına sağladığımız katkının yanı sıra %97 oranında doğruluk payına sahip olan n-FasT Covid-19 hızlı tanı kitini üreterek pandemi sürecinde hastalığın teşhisinin çok daha hızlı ve verimli bir şekilde konulmasını sağladık.

Geçmişimizi bilme, bugünü anlama ve geleceği inşa etme prensibi ile tüm imkânlarımızı insanlığın istifadesine sunuyor, Ahlatcı Holding olarak çözümün parçası olma irademizi diri tutuyoruz. Faaliyet gösterdiğimiz 6 ana sektörde 49 şirket ve 4.100 çalışanımızla sadece kentimize katma değer üretmekle kalmıyor, ülkemizi uluslararası arenada yüceltmeye odaklanıyoruz.

Çorum Kenti başta olmak üzere, ulusal ve uluslararası camiada önem taşıyacak olan "Eskiçağda Salgın ve Hastalıklar" adlı bu eserin hazırlamasında büyük emekleri olan ve kitabın editörlüğünü üstlenen, uzun yıllar Çorum'a hizmet vermiş, Ahlatcı ailesinin dostları Hititolog Doç. Dr. Özlem Sir Gavaz ve Hititolog Dr. Öğrt. Üyesi Gülgüney Masalcı Şahin'e tebrik ve teşekkür ediyor, kitaba değerli makaleleri ile katkı sunan bilim insanlarına da ayrıca şükranlarımı sunuyorum. Bu kitap projesinin katkılarımız ile yayınlanıyor olmasından onur duyuyor, gelecek nesilleri aydınlatacağı inancımla tüm okuyuculara saygılarımı sunuyorum.

Ahmet Ahlatcı
Ahlatcı Holding Yönetim Kurulu Başkanı
Ağustos 2021

An Overview of the Evidence for Infectious Disease in Pharaonic Egypt

Lisa Sabbahy

Ancient Egyptian cemeteries were located on both sides of the Nile river, on hot, dry desert plateaus. This dry environment, combined with the ancient Egyptian belief that the deceased needed their physical body in the afterlife, necessitating the treatment and preservation of the body, resulted in the discovery of a large amount of human skeletal material by archaeologists, including mummies that provide evidence of not only bones, but also soft tissue. This abundance of well-preserved human remains has aided in the development of a comprehensive modern understanding of disease in ancient Egypt. The study presented in this article provides an overview of infectious disease in ancient Egypt, incorporating the most recent physical evidence, as well as the most advanced medical technology available to study it. The discussion will focus on pharaonic Egypt (3200-332 BCE), but will extend into Ptolemaic-Roman Egypt (332 BCE-395 CE) in the case of leprosy. The first part will address three diseases: leprosy, smallpox and polio. The extent of these three diseases is unknown, and they may have been relatively uncommon in ancient Egypt. The second part will discuss three infectious diseases that had a significant impact on ancient Egyptians: tuberculosis, schistosomiasis and malaria.

Polio

There is very little evidence of polio in ancient Egypt. The evidence is based on the depiction of a man on a stela from the late Eighteenth or Nineteenth Dynasty that is now housed in Copenhagen's Carlsberg Glyptotek Museum. The stela depicts Roma, the doorkeeper, standing in front of an offering table with a "grossly wasted and shortened leg" (Nunn, 1996: 77). He stands with a long staff held against his left side, despite the fact that both of his hands are occupied by offerings. Behind him are his wife, with additional offerings, and their child. The only actual paleopathological evidence that could indicate the presence of polio in ancient Egypt is the shortened and deformed leg of King Siptah of the late Nineteenth Dynasty, which has been described as resembling "a post poliomyelitis deformity" (Whitehouse, 1980: 293). The most recent study on the subject of the existence of poliomyelitis in ancient Egypt, published in 2016, concludes that "the presence of poliomyelitis in Ancient Egypt should be considered speculative" (Galassi et al., 2016). In response to Harris and Wente's statement about King Siptah's deformed leg, the most recent comment is that the king "shows a shortened leg, but without an established aetiology" (Habicht et al., 2020: 217).

Smallpox

Smallpox is another infectious disease with paleopathological evidence dating back to ancient Egypt. Ruffer states in his publication of *Studies in the Palaeopathology of Egypt* that a small piece of skin removed from the thigh of a Twentieth Dynasty mummy presented an eruption that had a "general resemblance to smallpox" (Ruffer, 1921: 32). Sandison has accepted Ruffer's interpretation as a possibility (Sandison, 1972: 218), but this may have been because there appears to be fairly strong evidence that King Ramses V, who lived during that time period, died of smallpox (Sandison et al., 1998: 44). In 1994, Strouhal was granted permission to examine the mummy of Ramses V. He noted "clear pustular exanthema in the pubic area, the lower abdominal region and the face", all of which are expected places for evidence of smallpox (Strouhal, 1996: 317). In a chapter of a contemporary book, Lewin states that he was allowed to "collect minute scrapings which had peeled off" the Ramses V's neck, and these were sent to be tested at the Center for Disease Control in the United States (Lewin, 1996: 9). Using an

electron microscope, "smallpox-like particles were noted" and an "immunoprecipitation test for smallpox was also positive" (Lewin, 1996: 10-11, and figs. 2, A and B, and fig. 3). According to the most recent article on epidemic disease in ancient Egypt, "smallpox has not been identified in a molecular level in Ramses V" (Habicht et al, 2020: 218).

Leprosy

There is no evidence for leprosy in ancient Egypt until around 200 BCE, or early Ptolemaic times. This is in line with the theory that the Alexander the Great's army brought leprosy back from India (Mark, 2002: 285). Excavation of severely plundered Ptolemaic tombs at Balat in Dakhleh Oasis in the Western Desert uncovered remains of 71 individuals. Four skulls, all described as male, showed changes typical of leprosy. There were also phalanges found with such changes, but due to tomb plundering, these bones were unable to be connected to the skulls (Dzierzykray-Rogalski, 1980).

More cases of leprosy were discovered in a Roman Period cemetery at Kellis 2 in the Dakhleh Oasis, where 378 burials had been excavated. Two young male burials exhibited clear "skeletal changes pathognomic of lepromatous leprosy" while two other skeletons, also of young adult men, were "possible sufferers of this disease" (Molto, 2002: 179). A slightly later report from 2003 indicated that all four had tested positive for leprosy via DNA analysis and that that one young man from tomb K2 B116 had suffered from tuberculosis as well (Stewart et al., 2003: 376). This type of co-infection is not uncommon, and a superinfection with tuberculosis would result in an earlier death (Donoghue et al., 2005: 393). Additionally, the isotope analysis revealed that the young man in tomb K2 B116 was not originally from Dakhleh Oasis, and he did not "appear to share any maternal genetic characteristics" with the nearby burials analyzed. It has been suggested that perhaps he had migrated to the oasis was after being banished from the Nile Valley because of his disease (Dupras et al., 2001: 1204). Molto comments that, while the prevalence of leprosy was only 3.7% at Kellis 2 cemetery, it is possible that leprosy was endemic in Dakhleh Oasis (Molto, 2002: 182).

Later isotope work, done for a dissertation published in 2015, added significantly more information to our understanding of the Kellis 2 leprosy patients (Groff,

2015). By this time, 761 burials had been excavated, and eight cases of leprosy had been identified. This total indicates leprosy prevalence of 1.1% in the cemetery (Groff, 2015: 119) Five of these individuals were subjected to isotope analysis. The analysis confirmed that the young man buried in B116 was not a native of Dakhleh Oasis and had not been there for an extended period of time prior to his death. The man in Burial 6 was originally from the oasis but then had left for several years before returning. The man buried in in Burial 222 was a native of Dahkleh Oasis, but appeared to have traveled back and forth between the oasis and the Nile Valley. The older male who lived around forty years buried in B392 was a native of Dahkleh Oasis and had spent his entire life there. The fifth person, in burial 437 was the only female found with leprosy. She is listed in the 2003 report, but her sex is not discussed or identified (Stewart et al., 2003: 276). Isotope analysis shows she was from the Nile Valley, but spent at least the last ten years of her life in Dakhleh Oasis (Groff, 2015: 136-7).

Excavations were conducted at Abusir el-Meleq in Middle Egypt during the early 1900's, and human remains were transported to Germany. A bone sample was recently analyzed for DNA and Carbon 14 content. The sample, Abusir 1630, had a carbon date of 342-117 BCE and a DNA test revealed leprosy, despite the absence of visible bone deformity (Neukamm et al., 2020). This would place the sample between the Second Persian Period to approximately the reign of Ptolemy IX. The report claims that "Abusir 1630 is older than any published *M. leprae* genome to date" (Neukamm et al., 2020: 4). Due to the fact that the Ptolemaic skeletal remains from Balat discussed above are only dated Ptolemaic, this newly tested evidence may be older, but this cannot yet be proven.

Tuberculosis

Until recently, paleopathologists had to rely on bone lesions, especially in the thoracic and lumbar vertebrae, to diagnose tuberculosis, although these lesions could also be caused by other pathological conditions as well (Brown et al., 2011: 559-560). In their most severe form, tubercular lesions cause vertebral fusion and collapse, as seen in the mummy of the Twenty-First Dynasty High Priest of Amun at Karnak Temple, Nesperehan, who had an extremely bent spine, referred to as Pott's disease, and a psoas abscess in the lower right abdomen (Ruffer, 1921: 3-10). The term "Pott's disease" is derived from Sir Percival

Pott, a London surgeon who described this type of curved spine for the first time in 1779 (Strouhal, 1988: 181).

In the 1990s, work on ancient DNA began to recover DNA from viruses, bacteria and parasites, and in 1997, the first *Mycobacterium tuberculosis* DNA sequence was discovered in a mummy from Thebes, dating to the New Kingdom. The DNA evidence corroborated a macroscopic examination that revealed evidence of pulmonary tuberculosis in the mummy (Nerlich et al., 1997: 1404). Another method of identifying ancient tuberculosis is to use a technique that detects mycolic acids in the cell wall of *Mycobacterium tuberculosis*. The acids can be extracted and examined using high performance liquid chromatography to determine the type of cell from which the mycolic acid originated. This kind of analysis was used on the so-called Granville mummy, an older woman from Thebes, dating to the Late Period. Samples to test for *Mycobacterium tuberculosis* DNA were extracted from her gallbladder, lungs and membranous tissues, while samples for *Mycobacterium tuberculosis* mycolic acids were extracted from her lung and femur. All of these samples were positive and it was concluded that this woman's death was caused by an active tuberculosis infection (Donoghue et al., 2010; Donoghue, 2020).

In 1998, a team working at the late Predynastic Period site of Adaïma, in Upper Egypt recovered DNA of *Mycobacterium* from bone samples of a child with vertebral lesions. (Crubézy et al., 1998). The subsequent work with this DNA suggested that it was an ancestral form of *Mycobacterium tuberculosis* that existed during the period of urban settlement in the Nile Valley, beginning around 3400 BCE and eventually leading to the gradual formation of the Egyptian state (Crubézy et al., 2006: 13–21). It has now been demonstrated, using ancient DNA recovered from human remains at two additional Upper Egyptian sites, Abydos and Thebes, that throughout pharaonic history, from the Early Dynastic Period to the Late Period, roughly from 3000 to 664 BCE, the prevalence of tubercular disease in Egypt remained at about 25% (Zink et al., 2003: 248). This study tested a total of 83 samples, 18 of which were positive for *Mycobacterium tuberculosis* complex DNA. Six of the samples "came from individuals with macroscopic evidence of tuberculosis spondylitis", five samples came from individuals with "non-specific pathological alterations", and the last seven with "normally appearing vertebral bones" (Zink et al., 2003:239). "These results provide clear

evidence that the molecular analysis can detect DNA even in unremarkable bone tissue", (Zink et al., 2002: 59).

Additionally, as a result of the DNA work, particularly conducted by Zink's team on bone and tissue samples from Abydos and Thebes, distinct strains of tuberculosis have been identified. The earliest evidence from the Early Dynastic burials at Abydos, was for an ancestral strain of *Mycobacterium tuberculosis*. The samples from the Middle Kingdom at Thebes showed strains of *Mycobacterium africanum*, which may well reflect the Middle Kingdom's expansion of military power into Lower Nubia. At Thebes, samples from The New Kingdom to the Late Period, revealed a "modern strain of *M. tuberculosis*" (Zink et al., 2007: 387-388). It has always been assumed that ancient Egyptians contracted tuberculosis from their cattle, as cattle were a significant part of the agricultural economy were also sacrificed for temple and funerary food offerings. It is now clear that ancient Egypt did not have *Mycobacterium bovis*, the strain of tuberculosis carried by cattle, and that the most ancient strain of tuberculosis in ancient Egypt was a human strain (Nerlich et al., 2009; Taylor et al., 2007).

Two different cemeteries at Adaïma's Predynastic site have yielded human remains with evidence of tuberculosis. The East Cemetery is primarily composed of child burials. From 388 individuals who were excavated and examined, 23 had lesions consistent with "bony involvement of tuberculosis." The age range of the individuals was nine months to seven years (Crubézy et al., 2017: 62). One child aged four to five years from Tomb AD5 500 had "Pott's disease". According to the publication of this young child's skeletal evidence of tuberculosis, "tuberculosis must have been endemic throughout the population" at that early stage of Egypt's formation of a state (Dabernat et al., 2011: 719–730). The West Cemetery, which was heavily plundered in ancient times, was primarily used for the adult burials. Four of the 28 children or adolescents who could be properly examined had tuberculosis. One individual from Tomb S55 who died between the ages of twelve and fourteen "presented damage typical of Pott's disease" with "massive destruction and collapse of the vertebral bodies" (Crubézy et al. 2017: 66-67).

The significance of highlighting the devastation caused by spinal tuberculosis is that, because only a small percentage of individuals suffering from tuberculosis have "osseous involvement", these individuals may "indicate a much more wide-

spread epidemiological occurrence of the disease" (Zink et al., 2001: 355). Individuals found with skeletal tuberculosis may account for only about 1-3.5% of tuberculosis infections (Strouhal, 1988: 181). The latest publication on the Adaïma site, which came out in in 2017, discussed the frequency of bone tuberculosis during the late Predynastic Period at Adaïma. It is suggested that the high death toll among children is a result of an epidemic at the site, something that "has never been described" in the Predynastic Period in Egypt before. (Crubézy et al., 2017: 115).

Schistosomiasis

Due to Egypt's riverine environment, combined with the importance of agriculture, and the large population of rural people who worked near and in water, the parasitic disease schistosomiasis or bilharzia, was a wide-spread health problem in ancient Egypt. Even modern Egypt still "has some of the highest schistosomiasis rates in the world" (Kloos, 2002: 14). *Schistosoma haematobium* is a small parasite found in shallow slow-moving or still water, as well as in the mud along the sides of the river Nile, the natural swamps formed by the river, and the numerous canals cut by the ancient Egyptians not only for irrigation, but also for transportation.

The miniscule *S. haematobium* worm, whose host in the water is a snail, enters the skin and then produces thousands of eggs that settle in the bladder, kidneys and liver in particular. There is no archaeological evidence in ancient Egyptian villages of specific places designated for sanitation, and it is assumed that the area along the river and canals may have served as toilet areas. Urine and faeces would reintroduce parasite eggs back into the water, perpetuating the infection cycle. These parasites and their eggs have been discovered in visceral tissue from mummies, as well as viscera packs placed with mummies, and canopic jars (Rutherford, 2016: 164).

The earliest discovery of schistosomiasis in an ancient Egyptian mummy was Ruffer's discovery in 1910 of "calcified eggs of *Bilharzia haematobia*" in the kidneys of two mummies from the Twentieth Dynasty", 1186-1069 BCE, which he discovered in "microscopic sections" (Ruffer, 1910: 16. Perhaps the most dramatic case of schistosomiasis is that of Nakht, a sixteen-year-old weaver in Thebes, also

during the Twentieth Dynasty. Histopathologic examination of his mummy revealed the presence of schistosoma eggs throughout his gastrointestinal tract. They were also found in his large and small intestines, kidneys, and liver, which had developed cirrhosis as a result of the schistosomiasis (Reyman et al., 1977: 470-471). Additionally, the Reyman article mentions the possibility of two species of schistosomiasis, *haematobium* and *mansoni,* being present. The *haematobium* was clearly present in the gastrointestinal tract, but there may have been degenerated forms of *S. mansoni* eggs. Although the *S. mansoni* species typically responsible for cirrhosis caused by hepatic schistosomiasis, both species "may give the same histologic picture in the liver" (Reyman et al., 1977: 470-471).

Schistosoma mansoni was discovered in an ancient Egyptian mummy for the first time when the Manchester Museum commissioned two independent laboratories to do DNA tests on the mummies of the Middle Kingdom brothers, Nakht-Ankh and Khnum-Nakht. DNA for *S. mansoni* was found in Nakht-Ankh's liver, "suggesting he suffered from chronic schistosomiasis" (Matheson et al., 2014: 44). His liver sample was also positive for *S. haematobium,* as were the intestinal samples from Khnum-Nakht. These two men were from Deir Rifeh, a village near Asyut, in Middle Egypt, whereas the infected mummies discussed previously were from Thebes in southern Upper Egypt.

Not all of the ancient Egyptians who contracted schistosomiasis were village dwellers who might have worked in or around water. The Late Period (664-332 BCE) mummy of Asru, a woman in her fifties to sixties had a bladder sample removed via endoscopy, revealing she had schistosomiasis (David et al., 2003: 155). Asru was entombed in a painted wooden anthropoid coffin, which bore the inscription "chantress". Undoubtedly, this indicated that she was a chantress of the god Amun at Karnak Temple, suggesting that she probably came from an elite family.

It is also known that schistosomiasis existed during the earliest period in ancient Egyptian history, as a sample of shin tissue from the mummy of a Predynastic adolescent from Gebelein, mummy EA 32753, roughly dating to 3200 BCE, was tested via ELISA, or enzyme-linked immune assay, which revealed the presence of a schistosomiasis infection at the time of the child's death (Deelder et al., 1990: 724; Miller et al., 1992: 555; Taylor 2014: 109; Miller et al., 1993). Deedler's study,

which used ELISA to detect schistosome antigen, was also tested on cheek and colon samples from Nakht (Deedler et al., 1990: 724). It was known from earlier histopathic analysis that Nakht suffered from schistosomiasis, and this was confirmed by the ELISA diagnostic test (Rutherford, 2016: 164).

Malaria

Agriculture, irrigation, and crop cover, particularly that of grain, create an ideal environment for mosquitoes, increasing the risk of malaria for the people who live in agricultural areas. The entire Nile Valley in Egypt, and especially the Delta, was such an environment, and it is unsurprising that there was "widespread endemic malaria in the Nile Valley" (Smith-Guzmán, 2015b: 1). *Plasmodium falciparum*, the most lethal form of malaria, has been discovered in all time periods of ancient Egypt. (Nunn, 1996: 73), although the number of individuals infected with *P. falciparum* is often limited, as discussed further below.

Using the Para Sight TM-F test, skin samples from three Predynastic individuals (dating before 3000 BCE) in Gebelein in Upper Egypt, a muscle sample from a New Kingdom (1550-1069 BCE) individual on the West Bank of Thebes, and lung samples from two Ramesside Period (1295-1069 BCE) canopic jars were analyzed and all tested positive for the *Plasmodium falciparum* antigen (Miller et al., 1994: 31). The same "immunoenzymatic assay" was used on skin, muscle and bone from fifty individuals and suggested "an incidence of malaria of about 40%" (Massa et al., 2000: 7) in a study on mummies from the Predynastic Period at the Gebelein site, in the Marro collection in Turin.

Further research conducted slightly later in the Marro collection, revealed that an infant between the ages 15 and 18 months, dating to the end of the Early Dynastic Period or the very beginning of the Old Kingdom, around 2686 BCE, was infected with *P. falciparium* (Bianucci et al., 2008). However, two of the Predynastic samples tested by Miller in 1994, revealed no evidence of falciparum antigen (Bianucci, 2008: 1883). In the same year, Nerlich was able to demonstrate with DNA analysis that two individuals from tombs on the West Bank of Thebes, dating from the New Kingdom down to the Late Period (1550-1069 BCE), were infected with *P. falciparum* (Nerlich et al., 2008: 1318; Nerlich, 2016: 3). However, these two individuals were selected from a total of 91 who were tested.

There was a resurgence of interest in malaria in ancient Egypt, when the analyses done on the mummy of Tutankhamun were published in 2010. The DNA analysis showed that not only Tutankhamun, but also his grandparents, Yuya and Thuya, suffered from a *Plasmodium falciparum* infection, the most deadly strain of malaria (Hawass et al., 2010: 645). Even more compelling evidence for malaria has emerged from the Tell el-Amarna cemetery excavations since 2015, where human remains from the North Tombs Cemetery have a "raw prevalence rate" of 72.4% in malaria (Dabbs et al., 2015: 7; Dabbs et al. 2016).

The evidence from Tell el-Amarna is based on new criteria for identifying malaria in skeletal material. Five particular skeletal lesions, occurring together, have been shown to be indicative of a malaria infection: "cribra orbitalia, spinal porosity, humeral cribra, femoral cribra, and periostitis" (Smith-Guzmán, 2015a: 631). Not only the evidence for malaria, but also the "high frequencies of postweaning subadults and young adults" in the cemetery, as well as the presence of multiple burials, suggests that Tell el-Amarna "was plagued by an epidemic of massive proportions" (Dabbs et al., 2014: 236-238). The skeletal remains of the non-elite workers buried in both the South and the North Tombs Cemeteries reflect a life of extreme labour and nutritional deprivation, which undoubtedly made them more susceptible to infection and more likely to succumb to it. According to the most recent report on the excavation of 252 individuals from the North Tombs Cemetery, they were a "highly stressed, heavily worked population," with 90% of the population being under the age of 25 (Dabbs, 2020: 183).

Tutankhamun is believed to have been born in Tell el-Amarna, and spent at least the first ten years of his life there. Although an infection from a badly broken knee may have been the primary cause of his death, a malaria infection would undoubtedly have contributed to Tutankhamun's poor health (Hawass et al., 2010: 646; Hussein et al., 2013: 477-478).

A study of expanded agriculture and settlement in the Fayum from the Late Period to Roman times revealed that intensified irrigation and cultivation, combined with a growing population, resulted in increased malaria prevalence (Lalremuata et al., 2013). This situation in the Fayum was very similar to that in Tell el-Amarna during the city's establishment, except that the problem of malaria in the Fayum was exacerbated by co-infection with tuberculosis, which has not

been discovered at Amarna. Tissue taken from sixteen mummy heads was DNA tested; six individuals tested positive for *P. falciparum*, and four of those also suffered from *Mycobacterium tuberculosis* (Lalremuata et al, 2013: 2, Table 1).

Conclusion

Modern medical technology has enabled us to gain a much more comprehensive and accurate picture of the burden of certain diseases in ancient Egypt. As the discussion above has shown, ancient DNA is probably the most accurate method of disease detection, but unfortunately is also the most expensive and complicated. As discussed previously, DNA was successfully used to detect tuberculosis, leprosy, schistosomiasis and malaria, despite the fact that malaria cases were quite rare. Antigen detection has also been used to detect tuberculosis, schistosomiasis and malaria. Additionally, mycolic acids can be used to identity tuberculosis infections (Minnikin et al., 2020).

Tuberculosis appears to have existed at the time of the ancient Egyptian state's early formation and persisted throughout pharaonic history at a possible prevalence of 25% of the population. Tuberculosis was also discovered as a co-infection with malaria in the Late Period and Ptolemaic–Roman times in the Fayum Depression, and as a co-infection with leprosy in Roman times in the Dakhleh Oasis. Due to an environment and economy centered around the Nile River and agriculture, schistosomiasis and malaria must have been endemic in ancient Egypt, and at times malaria must have reached epidemic proportions, as evidenced by the remains of the labourers buried in the North Tombs Cemetery at Amarna. Both of these diseases, along with tuberculosis, were present in Predynastic times, just prior to and during the formation of the ancient Egyptian state. It is widely accepted that the average life expectancy in ancient Egypt was around 30 to 35 years (Nunn, 1996: 22). This low life expectancy could very well be the result of the chronic diseases discussed in this article, most notably tuberculosis, malaria and schistosomiasis (Nerlich et al., 2001: 341).

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