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Age and health in Roman Egypt

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Walter Scheidel

Stanford University

Abstract: Prepared for a forthcoming handbook of Roman Egypt, this paper surveys ancient and comparative evidence and modern interpretations of life expectancy, mortality patterns, and disease in ancient Egypt.

Age structure and life expectancy

Roman Egypt is the only part of the ancient world where documentary evidence for the age composition of the general population has survived. Pertinent information is provided by extant census returns from the first three centuries of Roman rule. Gathered every fourteen years, these documents list the members of individual households with their names, familial status, and ages. Some 850 records have become known to date (Bagnall, Frier and Rutherford 1997: 57-88; Bagnall and Frier 2006: 179-325). Knowledge of the age distribution enables us to track mortality rates and infer average life expectancy, which is a critical measure of overall wellbeing. In practice, however, the raw data reveal numerous deficiencies that interfere with straightforward demographic analysis (Fig. 1).

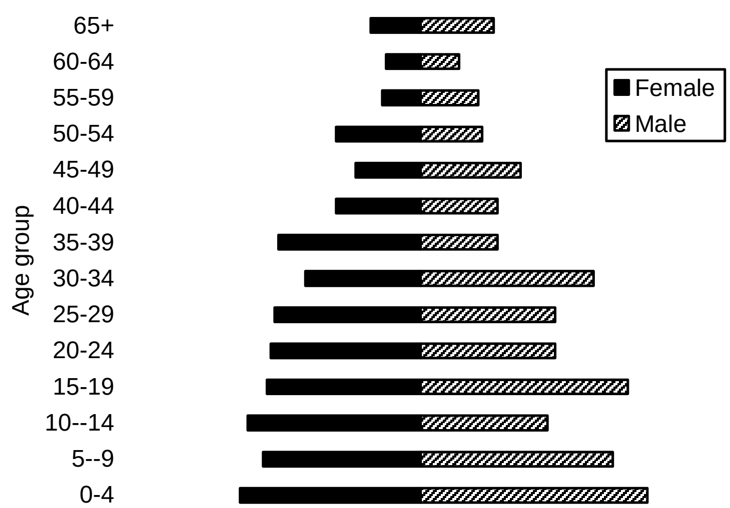

Fig. 1 Distribution of ages recorded in census documents from Roman Egypt (n=847)
Source: Bagnall and Frier 2006: 314-23, 348-50; Bagnall, Frier and Rutherford 1997: 100

In 1994, Roger Bagnall and Bruce Frier's study of this material transformed our understanding of Roman Egyptian population history by exploiting the census data with the help of modern demographic techniques. Drawing on 710 age records available at the time, they reconstructed the age distributions of the male and female populations and estimated mean life expectancy at birth. This procedure entailed several assumptions. Because urban data are overrepresented in the record, the raw data had to be adjusted to give due weight to evidence from the countryside. Gender rather than location was considered to be the crucial variable in accounting for differences in survival rates. Moreover, owing to the relative paucity of records for small children, average life expectancy at birth could not be directly measured and had to be derived by fitting the weighted and smoothed data to modern life tables (Bagnall and Frier 1994 = 2006: 75-110). Implied life expectancy at birth was very low, in the low to mid-twenties for women and in the mid- to late twenties for men. These values resemble those documented for China in the first millennium CE, in eighteenth-century France, in nineteenth-century Spain and Russia, and in India in the late nineteenth and early twentieth centuries (Scheidel in press a).

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Despite their ostensible plausibility, these findings are open to a number of criticisms. One is that modern life tables, which are primarily based on fairly recent census data, may not capture the full range of the mortality experience of pre-modern populations (Scheidel 2001a: 123-42; 2001b). More specifically, they tend to overstate deaths in childhood relative to those among adults. Alternative models have been developed to address this problem (Woods 2007). This raises the question with which, if any, modern model the Egyptian census data might best be compared. Another problem concerns the nature of the data: It has been argued that records for many male villagers are too corrupted by selective underreporting to be of much demographic value (Scheidel 2001a: 156-60). A third issue is that location may be a more significant determinant of mortality than gender. Urban census data fall into a pattern that differs from standard models by showing elevated rates of attrition among young and middle-aged adults (Fig. 2). If this divergence reflects reality, it may be interpreted as evidence of urban excess mortality driven by density-dependent disease (Scheidel 2001a: 144-56). A similar pattern is visible in a data set from an unknown city, probably Lykopolis, that was not initially available to Bagnall and Frier (*P.Oxy* 984A in Bagnall, Frier and Rutherford 1997). Census records for female villagers appear to be largely free from systematic distortions but remain insufficiently numerous to support firm estimates beyond a fairly wide range from 20 to more than 30 years of mean life expectancy at birth (Fig. 3; Scheidel 2001a: 160-2, 174-5).

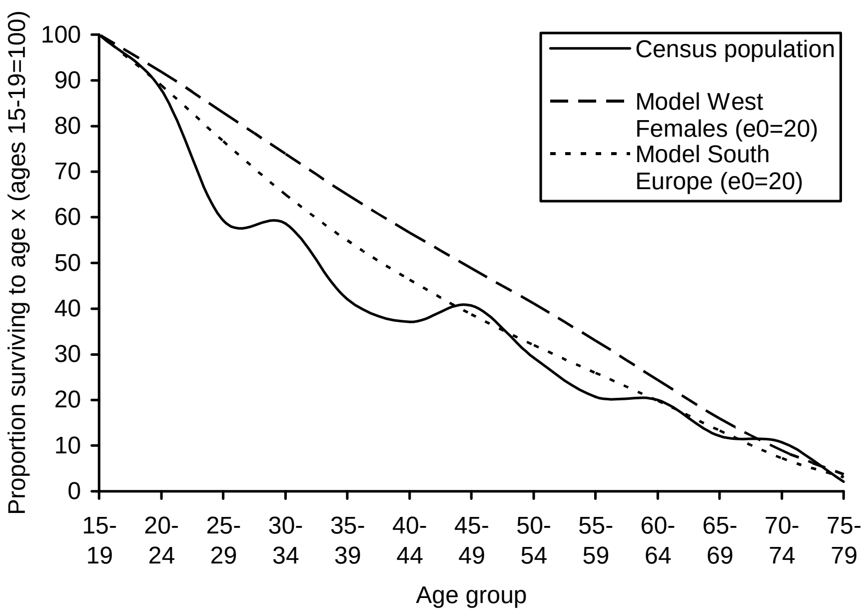

Fig. 2 Smoothed age distribution of the adult urban metropolitan census population of Roman Egypt (excluding lodgers and slaves) compared to model life tables
Source: Coale and Demeny 1983: 55; Scheidel 2001a: 155; Woods 2007: 379

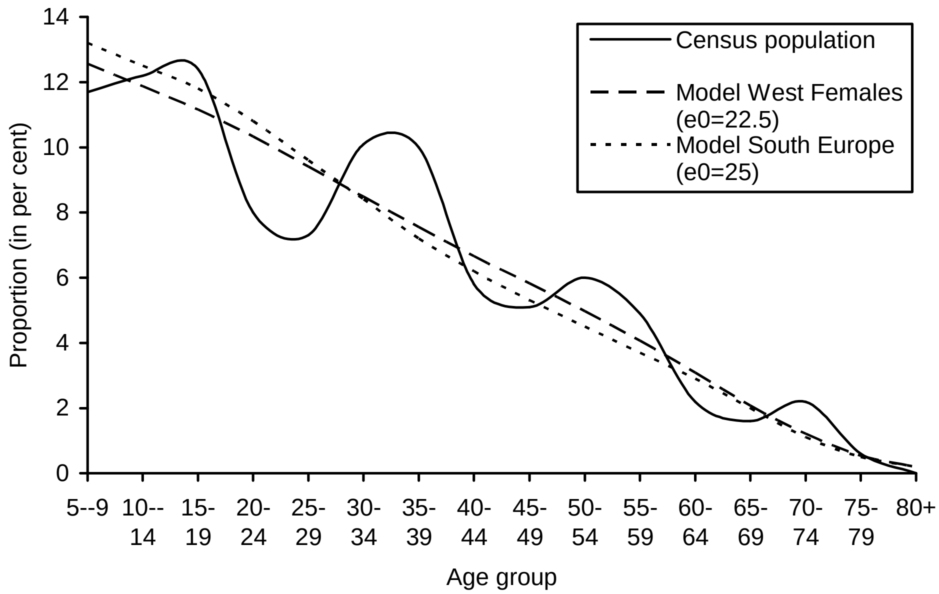

Fig. 3 Smoothed age distribution of the female census population of villages in Roman Egypt compared to model life tables
Source: Coale and Demeny 1983: 56; Scheidel 2001a: 161; Woods 2007: 379

Due to commemorative biases, the numerous ages recorded on tombstones and mummy labels do not provided usable information on life expectancy (Boyaval 1975, 1976). Yet even if reconstructions built on the census records are not as robust as initially surmised, they nevertheless point to very high mortality rates overall (Scheidel in press c). This notion is consistent with conditions in Egypt in the early twentieth century and may be explained with reference to environmental factors and unusually high population densities (Scheidel 2001a: 178, and see above, Chapter 9).

Mortality patterns

Dates of death recorded on tombstones and mummy labels help us gauge monthly variation in mortality. Most of this evidence comes from the Nile Valley south of the Delta, both in Egypt and in Nubia farther south. Greek epitaphs from the period of Roman rule as well as later Coptic records reveal a strong concentration of deaths in the spring. Months mentioned on mummy labels fall into a very similar pattern: Previously misunderstood as dates of death, they refer to the completion of mummification ten weeks later (Scheidel 1998). Adjusted accordingly, these records match the epigraphic profile (Fig. 4; Scheidel 2001a: 4-19).

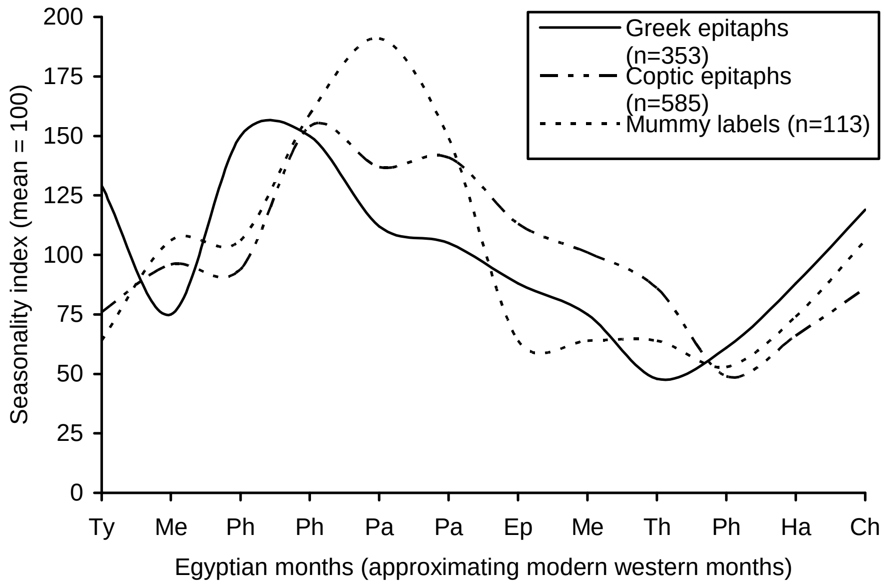

Fig. 4 Seasonal mortality in Upper Egypt and Nubia according to Greek and Coptic funerary inscriptions and adjusted dates on Greek mummy labels
Source: Scheidel 2001a: 6, 13

By contrast, Greek epitaphs from several sites in Lower Egypt and from the coast reveal substantially different distributions. Thus, data from Terenouthis and other sites in or near the Delta region show an increase in mortality in the fall and winter but a comparatively low incidence in the spring. Data from Alexandria are scarce but do not suggest any significant seasonal concentrations (Scheidel 2001a: 19-25). Surviving death declarations also frequently list dates of death but fail to contribute reliable information (Scheidel 1999).

Causes of death

The observed regional variations in seasonal mortality patterns indicate regional differences in the dominant causes of death. As in pre-modern societies more generally, infectious diseases can be expected to have accounted for the majority of deaths at most ages. Different infections flourished and affected people at different times of the year. The connection between the disease environment and seasonal mortality is visible in epitaphs from the city of Rome in late antiquity. They show a surge in the death rate during the late summer and early fall, at a time when malaria, which appears to have been endemic, used to flare up and exacerbate other diseases (Scheidel in press b). In Roman Egypt, by contrast, it is more difficult to establish a clear connection between seasonality profiles and particular diseases. Nevertheless, comparative data support the notion that the pattern documented for the Nile Valley reflected actual health conditions. Travelers' accounts from the sixteenth to the early nineteenth centuries consistently point to a concentration of fatal infections in the spring, variously reporting diarrhea, dysentery, typhus, typhoid, relapsing fever, jaundice, malaria, tuberculosis, smallpox, plague, and cholera, as well as severe conditions that cannot be properly identified (Scheidel 2001a: 110). With only few exceptions – cholera and perhaps smallpox and typhus – these diseases were already present in antiquity. Acting concurrently, they would have been powerful enough to skew mortality patterns in the observed fashion. As recently as in Cairo in 1859/60, "typhoid fevers" peaked at that time of the year (Schnepp 1862: 552-3). It is also worth noting that funerary inscriptions from late Roman Palestine show a comparable spike in deaths during the spring (Patlagean 1977: 92-4).

In Lower Egypt, by contrast, elevated death rates in the late fall and early winter may have been boosted by respiratory diseases precipitated by a somewhat cooler and wetter climate. If a large sample of seasonal mortality data from Terenouthis in Lower Egypt is disaggregated according to age, we find that the elderly were particularly vulnerable during the winter months, in much the same way as they were in the late antique city of Rome (Scheidel 2001a: 29; in press b). The notion that the annual inundation caused epidemics, already featured in incantations in Papyrus Edwin Smith from the sixteenth century BCE (Westendorf 1999: 20-1), appears to be borne out by the observed increase in deaths in both Upper and Lower Egypt during the last three months of the year, as the waters of the Nile receded from their peak in September. Malaria may well have been the principal culprit.

Thanks to its coastal location, Alexandria appears to have fared better (cf. also below), similar to late Roman Carthage which witnessed comparably aseasonal mortality. All this supports the notion that regional differences in the timing of mortality were a function of different disease regimes. It was only by the early twentieth century that seasonal mortality peaks in both Upper and Lower Egypt had shifted to the late spring and early summer. This suggests that causes of death changed in the very long term. We know that the presence and prevalence of diseases such as plague and smallpox varied over time. More generally, secular shifts in pathogen ecology seem to have been responsible for discontinuity between ancient or "archaic" conditions and a more recent pre-modern disease regime that took shape in the nineteenth century (Sandwith 1905; Jagailloux 1986; Kuhnke 1990; Scheidel 2001a: 109-17).

Disease and physical wellbeing

It is far easier to document the presence of certain diseases than to assess the relative importance of different causes of death. A wide range of techniques from textual study to biomolecular analysis have been brought to bear on the record. Thanks to the preservation of numerous mummified corpses and the exceptional time depth of the textual tradition, medically relevant evidence from ancient Egypt is particularly rich by pre-modern standards. This fortunate situation allows us not only to explore health conditions in the Roman period but also to place them in a broader context.

Medical and magical texts from the dynastic period contain a wealth of information about different diseases (Westendorf 1999: 101-459). These include heart ailments; headaches; skin diseases; various eye problems such as glaucoma, cataracts, and blindness; bone fractures, wounds, and other injuries; paralysis; respiratory ailments; worm infection, gastro-intestinal and urinary tract problems; fevers; bites (with most attention paid to snake bites but also featuring those by fellow humans, dogs, pigs, lions, hippos and crocodiles) as well as scorpion stings; and swellings and tumors. Symptoms indicative of mental illnesses are also reported. Medical investigation of mummies has primarily focused on the dynastic period (e.g., Rose 1996; Cockburn and Cockburn 1998: 15-117; Westendorf 1999: 460-3; David 2008). Iconographic evidence further supplements the bio-anthropological record (Westendorf 1999: 463-5).

Texts from the Roman period itself also shed light on medical conditions (Marganne 1981; Hirt Raj 2006: 264-78). A number of magical spells were designed to heal, prevent, or induce various illnesses (Bonner 1950; Betz 1992). In this genre, fever, often accompanied by shivering fits, is the most commonly mentioned affliction, followed by headaches, eye problems, hemorrhage, fractures, coughs, cysts, inflammations, swollen testicles, hardened breasts, breast and abdominal pain, tumors, ulcers, angina, scrofula, epilepsy, strangury, insomnia, scorpion stings, and 'elephantiasis.' These and other texts likewise betray anxiety about reproductive health. In addition, papyri preserve information about the medical profession in Roman Egypt (Marganne-Mélard 1996; Hirt Raj 2006).

Rare glimpses of actual cases of illness in the second century CE are afforded by ostraca from the Mons Claudianus mines in the eastern desert that report workers' health problems (Cuvigny 1992, 1997). "Hurt" tops the rankings, accompanied by fevers, eye ailments, scorpion stings, and inflammations of the uvula and tonsils. Unfortunately, generic sick lists that do not specify causes dominate this record. Surviving correspondence from the same site deals with the dispatch of assorted medical supplies.

In the most general terms, gastro-intestinal diseases such as diarrhea, dysentery, and typhoid must have been pervasive and the most common causes of death for young children (Scheidel 2001a: 62-75). These infections still dominated several cause-of-death statistics from Cairo and Alexandria in the late nineteenth and early twentieth centuries. Just as in medical writings from antiquity, however, they receive scant attention in Egyptian sources and are hard or impossible to trace in physical remains.

Malaria also played an important role (Scheidel 2001a: 75-91). All manifestations of malaria that used to be endemic in the Mediterranean – quotidian, tertian and quartan fevers, associated with *Plasmodium falciparum*, *vivax*, and *malariae* – are explicitly attested in charms from Greco-Roman Egypt (Betz 1992: 255, 267, 310-1). Hints at the occurrence of malaria can already be found in earlier periods, such as a warning in a temple inscription at Denderah not to leave home after sunset in the weeks following the inundation (when mosquitoes would have proliferated), reported strategies of mosquito evasion that are typical of malarial areas (Hdt. 2.95), and, possibly, reference to the "disease of the three days" (Westendorf 1999: 327, 460). *P. falciparum* is by far the most pernicious kind of malaria known from the region: both antigen to that parasite and the actual parasite's DNA have been extracted from dynastic-period mummies (Miller et al. 1994; Nerlich et al. 2008). The same type of malaria was still common in Egypt in the 1930s, suggesting continuity in the long term. Comparative evidence makes it seem likely that the marshy Fayum would have been particularly exposed to endemic malaria. This must be taken into account in demographic evaluations of the census returns, many of which originate from that part of the country. Ancient claims that Alexandria was free from marsh vapor diseases (i.e., malaria) may be correct but should nevertheless be treated with caution (Strabo 17.1.7; Galen vol. 16 p.363 ed. Kühn).

The incidence of tuberculosis in ancient Egypt has been the subject of considerable debate, in the first instance because physical evidence used to be limited to bone lesions suggestive of extrapulmonary tuberculosis or Pott's disease. Many reported cases remain uncertain (Buikstra, Baker and Cook 1993: 38-45), and in any case only a tiny proportion of patients can be expected to develop bone lesions before they die. More recently, the discovery of molecular evidence of pulmonary tuberculosis has profoundly changed the state of our knowledge. The first reported extraction of *Mycobacterium tuberculosis* DNA from lung tissue in a New Kingdom mummy (Nerlich et al. 1997) has since been followed by much richer findings drawn from a series of tombs ranging from 3500 to 500 BCE (Zink et al. 2004; cf. also Donoghue et al. 2010). Specimens dating from 1500 to 500 BCE have been characterized as modern *M. tuberculosis* strains (Zink et al. 2007), which implies that patients would have exhibited familiar pathologies.

Although no DNA data from the Roman period have so far been published, we may safely assume that pulmonary tuberculosis was present and, if the earlier molecular evidence is representative, potentially quite widespread. Even so, we also must allow for significant variation over time (Scheidel 2001a: 91-3).

A related pathogen, *Mycobacterium leprae*, is now equally solidly attested in Roman Egypt. Evidence of leprosy in the dynastic period remains tenuous (Nunn 1996: 74-5; Westendorf 1999: 312). Very late antique physical evidence from a sixth-century CE Coptic body has been recognized for a long time (Sandison and Tapp 1998: 42), later followed by the tentative identification of leprosy in Ptolemaic skeletons in Dakhleh Oasis in the western desert (Dzierzykray-Rogalski 1980). The same site has more recently yielded richer skeletal evidence from the fourth century CE. While studies of bone lesions have suggest only a few probable or possible cases (Molto 2002), DNA analysis has yielded a higher rate of leprosy infection, repeatedly coinciding with tuberculosis (Donoghue et al. 2005). This meshes well with the fact that Roman authors regarded *elephantiasis* (i.e., leprosy: Grmek 1989: 168-9) as a native disease of Egypt (Lucret. 6.1114-5; Plin. *HN* 26.5). In the second century CE the famous physician Galen considered it to be rife in Alexandria (vol. 11 p.142 ed. Kühn).

Pulmonary afflictions discovered in dynastic-period mummies include anthracosis (Walker et al. 1987) and fibrosis of the lung caused by the inhalation of sand particles (Sandison and Tapp 1998: 53), and would also have been present in the Roman period. Intestinal parasites added to the mix: Guinea-worm disease was ascribed to Egypt by Greek and Roman authorities (Adamson 1988). Schistosomiasis has been common throughout Egyptian history (Miller et al. 1992; Westendorf 1999: 469-71; Lambert-Zazulak, Rutherford and David 2003). The detection of schistosome antigen in New Kingdom mummies quite strikingly documents the spread of this condition, otherwise historically associated with farmers, even into elite circles (Deelder et al. 1990; Ziskind 2009). According to the second-century CE medical writer Aretaios (1.9.3-5), diphtheria was very common in Egypt and known as "Egyptian ulcers." What the Elder Pliny called *lichen* or *mentagra*, a pustulous skin eruption spreading from the mouth, was likewise reportedly well-known in Roman Egypt (*HN* 26.2-3; cf. *P.Vindob.* 6257?). Gout has also been observed (Sandison and Tapp 1998: 48-9; Hirt Raj 2006: 275-6).

Our knowledge of the history of smallpox in ancient Egypt depends to a significant extent on the answer to the question of whether lesions on the mummy of pharaoh Ramses V (d. 1145 BCE) were indeed caused by this disease (Hopkins 2002: 14-5). Possible evidence is both scarce and ambiguous. It now seems likely that in antiquity, smallpox did not commonly occur west of India (Li et al. 2007: 15790). The so-called "Antonine Plague' of the late second century CE is often considered to have been a smallpox pandemic. Given high population densities, this disease might well have become endemic in Egypt at the time, but we lack positive evidence for this assumption (Scheidel 2001a: 94-7). Convincing accounts do not appear until the early seventh century CE when Aaron of Alexandria described smallpox and measles. From the ninth century CE onward, smallpox was known as an endemic disease of childhood in the Near East (Hopkins 2002: 166-8).

Bubonic plague, on the other hand, was already ascribed to North Africa in the Hellenistic period and portrayed as prevalent in Libya, Egypt, and Syria in the second century CE (Thüry 1977; cf. Panagiotakopulu 2004). However, specific outbreaks are not documented prior to the great plague pandemic of the sixth to eighth centuries CE (Stathakopoulos 2004). While *Yersinia pestis* DNA has already been recovered from European skeletons from that period, it has yet to be identified in ancient Egyptian remains.

Dental studies suggest changes in the very long run. Thus, the incidence of enamel hypoplasia (a marker of developmental stress in children) in Greco-Roman finds from Mendes is considerably lower than in specimens from the Old Kingdom (Lovell and Whyte 1999). A more wide-ranging diachronic study of Egyptian samples has found significantly lower levels of occlusal tooth wear and higher rates of caries in the Greco-Roman period than in previous periods of Egyptian history. This may have been a function of changes in cereal consumption such as access to better grains or improved sieving techniques and of increasing use of sweeteners (Miller 2008: 68).

As already noted in the discussion of tuberculosis and leprosy, in recent years the skeletal remains from Dakhleh Oasis have been subject to very fruitful scientific analysis. One study found a lower incidence of *cribra orbitalia* (skull lesions associated with chronic iron deficiency anemias and other disorders) in Roman remains than in those from earlier periods, although the Roman rate is nevertheless fairly high even by ancient standards (Fairgrieve and Molto 2000; cf. Scheidel in press a). Another study failed to find evidence of bone infections in a sizeable sample from the same site (Cook, Molto and Anderson 1989). One local female Roman-period skeleton indicates hyperparathyroidism (Cook, Molto and Anderson 1988). Isotopic analysis of teeth has shed new light on child feeding practices: While supplemental foods began to be provided from the age of six months onward, breastfeeding was not completed until the age of three years, in keeping with textual references to prolonged breastfeeding (Dupras et al. 2001; Dupras and Tocheri 2007). Extended breastfeeding would have conferred health benefits and contrasts favorably with isotopic evidence of much earlier weaning in Portus near Rome (Prowse et al. 2008).

More recent work on the Greco-Roman remains of Bahriya Oasis further north has focused on spinal health. In addition to evidence for degenerative arthritis and degenerative bone lesions, researchers found an extremely high rate of *spina bifida occulta*, a congenital malformation that may have resulted from high levels of consanguinity in the isolated oasis population (Hussien et al. 2009). This last point raises questions about the medical consequences of brother-sister marriage as it is documented in numerous Roman Egyptian census returns. Provided that this custom was real and not merely entailed notional sibling unions created through adoption (cf. above, Chapter 20), it ought to have had significant deleterious effects (Scheidel 1996: 9-51). However, empirical evidence is lacking. This calls for further study.

On occasion, extraordinary epidemics would have further added to the overall disease load (Casanova 1984). The severity of first of the two best-known cases from the Roman period, the “Antonine Plague” of the late second century CE (probably smallpox), cannot be measured directly. Modern assessments rely on indirect indicators such as drops in population registers and subsequent changes in the value of land and labor. The plague pandemic of the sixth to eighth centuries CE appears to have had greater impact (Scheidel 2002; in press c).

Conclusions

Herodotus’ sweeping claim that “the Egyptians are the healthiest of men, next to the Libyans” (2.77.3) is impossible to reconcile with evidence from antiquity or any other known historical period. On the contrary, for millennia Egypt appears to have been a hotbed of disease. Life was short even by pre-modern standards, and seasonal infections ravaged even people in the prime of life. Locational differences – between city and countryside and between different parts of the country – are discernible in the record. Observed mortality patterns can only tentatively be linked to evidence of particular diseases, and it is even more difficult to gauge the consequences of major epidemics.

The scientific study of human remains has made enormous progress in recent years and already greatly enriched our knowledge of medical conditions in ancient Egypt. Even so, much more work needs to be done to give us a better sense of the relative prevalence of particular diseases and of change over time. We also need to bear in mind that the most common health problems, caused by gastro-intestinal bacillary infections, are among the most difficult ones to document in the physical record. At the same time, analysis of dental structure and osseous lesions is capable of elucidating health and overall living conditions with respect to diet, work conditions, and class and gender inequality (cf., e.g., Zaki, Hussien and El Banna 2009). A steady progression from the study of disease to a more comprehensive history of wellbeing is the most promising path for the future.

References

Adamson, P.B. 1988. "Dracontiasis in antiquity," *Medical History* 32: 204-9.

Bagnall, R.S. and Frier, B.W. 1994. *The demography of Roman Egypt*. Cambridge: Cambridge University Press. Rev. ed. 2006.

Bagnall, R.S., Frier, B.W., and Rutherford, I.C. 1997. *The census register P.Oxy 984: the reverse of Pindar's Paeans*. Brussels: Fondation Égyptologique Reine Élisabeth.

Betz, H. D. 1992. *The Greek magical papyri in translation including the demotic spells*. 2nd ed. Chicago: University of Chicago Press.

Bonner, C. 1950. *Studies in magical amulets, chiefly Graeco-Egyptian*. Ann Arbor: University of Michigan Press.

Boyaval, B. 1975. "Remarques à propos des indications d'âges des etiquettes de momies," *Zeitschrift für Papyrologie und Epigraphik* 18: 49-74.

Boyaval, B. 1976. "Remarques sur les indications d'âges de l'épigraphie funéraire d'Egypte," *Zeitschrift für Papyrologie und Epigraphik* 21: 217-43.

Buikstra, J.E., Baker, B.J., and Cook, D.C. 1993. "What diseases plagued the ancient Egyptians? A century of controversy considered," in W.V. Davies and R. Walker (eds.) *Biological anthropology and the study of ancient Egypt*. London: British Museum Press, 24-53.

Casanova, G. 1984. "Epidemie e fame nella documentazione greco d'Egitto," *Aegyptus* 64: 163-201.

Coale, A.J. and Demeny, P. 1983. *Regional model life tables and stable populations*. 2nd ed. New York: Academic Press.

Cockburn, A. and Cockburn, E. (eds.) 1998. *Mummies, disease, and ancient cultures*. 2nd ed. Cambridge: Cambridge University Press.

Cook, M., Molto, E.L., and Anderson, C. 1988. "Possible case of hyperparathyroidism in a Roman period skeleton from the Dakhleh Oasis, Egypt, diagnosed using bone histomorphometry," *American Journal of Physical Anthropology* 75: 23-30.

Cook, M., Molto, E.L., and Anderson, C. 1989. "Fluorochrome labelling in Roman period skeletons from Dakhleh Oasis, Egypt," *American Journal of Physical Anthropology* 80: 137-43.

Cuvigny, H. 1992. "La mort et la maladie," in *Mons Claudianus: ostraca graeca et latina, I (O.Claud. 1 à 190)*. Cairo: Institut francais d'archéologie orientale, 75-109.

Cuvigny, H. 1997. "La mort et la maladie (191-223)," in *Mons Claudianus: ostraca graeca et latina, II: O.Claud. 191 à 416*. Cairo: Institut francais d'archéologie orientale, 19-41.

David, R. (ed.) 2008. *Egyptian mummies and modern science*. Cambridge: Cambridge University Press.

Deelder, A.M. et al. 1990. "Detection of schistosome antigen in mummies," *Lancet* 335: 724-5.

Donoghue, H.D. et al. 2005. "Mycobacterium leprae in human archaeological samples: a co-infection of Mycobacterium tuberculosis and possible explanation for the historical decline of leprosy," *Proceedings of the Royal Society B: Biological Sciences* 272: 389-94.

Donoghue, H.D. et al. 2010. “Tuberculosis in Dr Granville's mummy: a molecular re-examination of the earliest known Egyptian mummy to be scientifically examined and given a medical diagnosis,” *Proceedings of the Royal Society B: Biological Sciences* 277: 51-56.
Dupras, T.L. et al. 2001. “Infant feeding and weaning practices in Roman Egypt,” *American Journal of Physical Anthropology* 115: 204-12.
Dupras, T.L. and Tocheri, M.W. 2007. “Reconstructing infant weaning histories at Roman period Kellis, Egypt using stable isotope analysis of dentition,” *American Journal of Physical Anthropology* 134: 63-74.
Dzierzykray-Rogalski, T. 1980. “Paleopathology of the Ptolemaic inhabitants of Dakleh Oasis (Egypt),” *Journal of Human Evolution* 9: 71-4.
Fairgrieve, S.I. and Molto, J.E. 2000. “Cribra orbitalia in two temporally disjunct population samples from the Dakhleh Oasis, Egypt,” *American Journal of Physical Anthropology* 111: 319-31.
Grmek, M.D. 1989. *Diseases in the ancient Greek world*. Baltimore: Johns Hopkins University Press.
Hirt Raj, M. 2006. *Médecins et maladies de l’Égypte romaine: etude socio-légale de la profession médicale et de ses praticiens du Ier au IVe siècle ap. J.-C*. Leiden: Brill.
Hopkins, D.R. 2002. *The greatest killer: smallpox in history*. Chicago: University of Chicago Press.
Hussien, F.H. et al. 2009. “Spinal pathological findings in ancient Egyptians of the Greco-Roman period living in Bahriyah Oasis,” *International Journal of Osteoarchaeology* 19: 613-27.
Jagailloux, S. 1986. *La médicalisation de l’Egypte au XIXe siècle (1798-1918)*. Editions Recherche sur les Civilisations.
Kuhnke, L. 1990. *Lives at risk: public health in nineteenth-century Egypt*. Berkeley: University of California Press.
Lambert-Zazulak, P.I., Rutherford, P., and David, A.R. 2003. “The International Ancient Egyptian Mummy Tissue Bank at the Manchester Museum as a resource for the palaeoepidemiological study of schistosomiasis,” *World Archaeology* 35: 223-40.
Li, Y. et al. 2007. “On the origin of smallpox: correlating variola phylogenics with historical smallpox records,” *Proceedings of the National Academy of Sciences* 104: 15787-92.
Lovell, N.C. and Whyte, I. 1999. “Patterns of dental enamel defects at ancient Mendes, Egypt,” *American Journal of Physical Anthropology* 110: 69-80.
Marganne, M.-H. 1981. *Inventaire analytique des papyrus grecs de medicine*. Geneva: Droz.
Marganne-Mélard, M.-H. 1996. “La médicine dans l’Egypte romaine: les services et les méthodes, ” in *Aufstieg und Niedergang der römischen Welt* II.37.3. Berlin: De Gruyter, 2709-40.
Miller, J. 2008. *An appraisal of the skulls and dentition of the ancient Egyptians, highlighting the pathology and speculating on the influence of diet and environment*. Oxford: Archaeopress.
Miller, R.L. et al. 1992. “Palaeoepidemiology of Schistosoma infection in mummies,” *British Medical Journal* 304: 555-6.
Miller, R.L. et al. 1994. “Diagnosis of Plasmodium falciparum infections in mummies using the rapid manual *Para*Sight™-F test,” *Transactions of the Royal Society of Tropical Medicine and Hygiene* 88: 31-2.
Molto, J.E. 2002. “Leprosy in Roman period skeletons from Kellis 2, Dakhleh, Egypt,” in C.A. Roberts, M.E. Lewis, and K. Manchester (eds.), *The past and present of leprosy*. Oxford: Archaeopress, 179-92.
Nerlich, A. et al. 1997. “Molecular evidence for tuberculosis in an ancient Egyptian mummy,” *Lancet* 350: 1404.
Nerlich, A.G. et al. 2008. “*Plasmodium falciparum* in ancient Egypt,” *Emerging Infectious Diseases* 14: 1317-9.
Nunn, J.F. 1996. *Ancient Egyptian medicine*. London: British Museum Press.

Panagiotakopulu, E. 2004. “Pharaonic Egypt and the origins of plague,” *Journal of Biogeography* 31: 269-75.
Patlagean, E. 1977. *Pauvreté économique et pauvreté sociale à Byzance, 4e-7e siècles*. Paris: Mouton.
Prowse, T.L. et al. 2008. “Isotopic and dental evidence for infant and young child feeding practices in an imperial Roman skeletal sample,” *American Journal of Physical Anthropology* 137: 294-308.
Rose, J.C. 1996. *Bioarchaeology of ancient Egypt and Nubia: a bibliography*. London: British Museum Press.
Sandison, A.T. and Tapp, E. 1998. “Disease in ancient Egypt,” in Cockburn and Cockburn (eds.) 1998: 38-58.
Sandwith, F.M. 1905. *The medical diseases of Egypt*. London: Henry Kimpton.
Scheidel, W. 1996. *Measuring sex, age and death in the Roman empire: explorations in ancient demography*. Ann Arbor: Journal of Roman Archaeology.
Scheidel, W. 1998. “The meaning of dates on mummy labels: seasonal mortality and mortuary practice in Roman Egypt,” *Journal of Roman Archaeology* 11: 285-92.
Scheidel, W. 1999. “The death declarations of Roman Egypt: a re-appraisal,” *Bulletin of the American Society of Papyrologists* 36: 53-70.
Scheidel, W. 2001a. *Death on the Nile: disease and the demography of Roman Egypt*. Leiden: Brill.
Scheidel, W. 2001b. “Roman age structure: evidence and models,” *Journal of Roman Studies* 91: 1-26.
Scheidel, W. 2002. “A model of demographic and economic change in Roman Egypt after the Antonine Plague,” *Journal of Roman Archaeology* 15: 97-114.
Scheidel, W. in press a. “Physical wellbeing,” in W. Scheidel (ed.), *The companion to the Roman economy*. Cambridge: Cambridge University Press.
Scheidel, W. in press b. “Disease and death,” in P. Erdkamp (ed.), *The companion to ancient Rome*. Cambridge: Cambridge University Press.
Scheidel, W. in press c. “Roman wellbeing and the economic consequences of the Antonine Plague,” in E. Lo Cascio (ed.), *L’impatto della “peste antonina.”* Bari: Edipuglia.
Schnepp, M.B. 1862. “Considérations sur le mouvement de la population en Egypte,” *Mémoires ou travaux originaux présentés et lus à l’Institut Egyptien* 1: 525-600.
Stathakopoulos, D. C. 2004. *Famine and pestilence in the late Roman and early Byzantine empire: a systematic survey of subsistence crises and epidemics*. Aldershot: Ashgate.
Thüry, G.E. 1977. “Zur Infektkette der Pest in hellenistisch-römischer Zeit, ” in *75 Jahre Anthropologische Staatssammlung München 1902-1977*. Munich: Anthropologische Staatssammlung, 275-83.
Walker, R. et al. 1987. “Tissue identification and histologic study of six lung specimens from Egyptian mummies,” *American Journal of Physical Anthropology* 72: 43-8.
Westendorf, W. 1999. *Handbuch der altägyptischen Medizin, I*. Leiden: Brill.
Woods, R.I. 2007. “Ancient and early modern mortality: experience and understanding,” *Economic History Review* 60: 373-99.
Zaki, M.E., Hussien, F.H., and El Banna, A.E.-S. 2009. “Osteoporosis among ancient Egyptians,” *International Journal of Osteoarchaeology* 19: 78-89.
Zink, A.R. et al. 2004. “Molecular identification and characterization of Mycobacterium tuberculosis complex in ancient Egyptian mummies,” *International Journal of Osteoarchaeology* 14: 404-13.
Zink, A.R.et al. 2007. “Molecular history of tuberculosis from ancient mummies and skeletons,” *International Journal of Osteoarchaeology* 17: 380-91.
Ziskind, B. 2009. “Urinary schistosomiasis in ancient Egypt,” *Nephrologie & Therapeutique* 5: 658-61.