ARCTOS

Acta Philologica Fennica

VOL. LII

VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

HELSINKI 2018

ARCTOS – ACTA PHILOLOGICA FENNICA

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Publisher:
Klassillis-filologinen yhdistys – Klassisk-filologiska föreningen (The Classical Association of Finland), c/o House of Science and Letters, Kirkkokatu 6, FI – 00170 Helsinki, Finland.

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ISSN 0570–734–X

Layout by Maija Holappa

Printed by KTMP Group Oy, Mustasaari

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THE ANTONINE PLAGUE REVISITED

R. P. Duncan-Jones*

1. Introduction

The Roman world was no stranger to lethal epidemic. Systematic records over long periods suggest a significant disease outbreak roughly every 10 to 20 years.[1] But the Antonine plague stood out for its force and virulence.[2] Nevertheless, Gilliam's minimising account in 1961 rapidly became a standard view.[3] But his interpretation no longer seems to be generally accepted.[4] The writer

* I am much indebted to Professors C. P. Jones and V. Nutton, together with the anonymous referees, for their valuable help, although they bear no responsibility for any statement. I must also thank Dr A. M. Burnett for his kind help.

[1] Paine - Storey (2012, 183) from the annalistic tradition for the years 490–292 and 212–165 BCE (also Duncan-Jones 1996, 111). An average of one epidemic outbreak every 11.6 years has been estimated for the period 541–750 CE (Stathakopoulos 2007, 105).

[2] R. P. Duncan-Jones "The Impact of the Antonine Plague" *JRA* 9:1996, 108–36, called **IAP** below. The evidence for the later Cyprianic plague (Harper 2015) is also plentiful, but depends partly on contemporary Christian sources which happen to be rare in the Antonine period

[3] Gilliam 1961.

[4] See for example Lo Cascio 2012a, 7–9 and *passim*; Liebeschuetz 2001, 397; Papi 2004, 61; Jongman 2006, 243; Sallares 2007, 37; Rathbone 2007, 700; Giardina 2007, 757; Malanima 2013, 27–8; Temin 2013, 84–5; Mattern 2013, 198–9; Harris 2016, 63, n.330; Harper 2017, 98–115; (in contrast to Bruun 2007 and 2012; cf. Elliot 2016). Gilliam (1961, 241) conceded that "there was a great and destructive epidemic under Marcus Aurelius". But he doubted "whether this plague contributed significantly to depopulation" (*ibid.* 251), and he set the death-rate too low to have any noticeable effect; see IAP, 116, n.88; Bray 1996, 15. Gilliam emphasised Dio's reference to the plague of 189 as the biggest he had known (*ibid.* 231); but Dio was too young to have known the great plague of the 160's except as a very small child (Millar 1963, 13, n.4). Gilliam (*ibid.* 248) also suggested that had Galen lived under Augustus, Nero or Titus, we would deduce another great plague, and the Antonine

took a more positive view in 1996, and after twenty years, that assessment can be updated and extended.[5]

In the late 170's a senator described the current plague as "that pestilence so great that it could not be cured by any medicine".[6] The plague was seen as one of the hallmarks of Marcus's reign.[7] When it first struck, Galen, the one available medical observer, soon abandoned Rome, where the disease killed almost all his slaves.[8] He also witnessed the return of plague in 168 which forced the two Emperors out of Aquileia, one of them dying suspiciously soon on the journey home.[9] The historian Dio witnessed one of the later outbreaks in 189, which he says killed 2,000 people per day (n.16 below). And even two centuries later, the leading historian Ammianus Marcellinus singled out the Antonine plague as an event which "after generating the virulence of incurable disease (under Marcus and Verus), polluted everything with contagion and death, from the frontiers of Persia all the way to the Rhine and to Gaul."[10]

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event would shrink in importance. But the Antonine dossier would remain sizeable even without Galen, see IAP, 118–120, whereas the earlier outbreaks are not widely corroborated, IAP, 111 and n.29.

[5] IAP examined the written evidence, together with the Roman plague tradition as a whole, and assembled proxy data. Many examples from the earlier paper are included here for the reader's convenience, usually without repeating references in detail.

[6] In a verbatim account of a senatorial debate: *CIL* II 6278 = *ILS* 5163, line 1; Duncan-Jones 2016, 74 (not in Gilliam 1961).

[7] Hist. Aug. *M. Ant.* 28,4 records his death-bed saying "Why weep for me rather than for the plague and those whom it killed?" For this source, see n.51 below.

[8] For his slaves, see Galen, *Avoiding distress*, in Nutton 2014, 77–9 (not in the Kuhn edition of Galen). Nutton suggests that the slave deaths took place in one of the plague outbreaks in the 170's or 180's (*ibid.* 78, n.6). But Teuchras, Galen's Pergamum friend living in Rome, died in the first outbreak (*ibid.* 88–9).

[9] IAP 118 and n.104; 109 and n.99. The more explicit tradition depicts a fatal seizure, 'apoplexin', while Verus was in the carriage with his brother setting out from Concordia, Eutr. 8,10; "between Concordia and Altinum", Hier. 205 Helm; *Epit.de Caes.* 16,5; Oros. 7.15.3. Hist. Aug. *Verus* 9,11 places his death in Altinum itself, "after three days without speaking". Altinum, the substantial predecessor of Venice, was two or three stages from Aquileia on the via Annia. Galen states that Verus died on the journey back to Rome (*de libr.propr*., Moraux 1985, 106). An alternative tradition attributes Verus's death to the normal Imperial hazard of poisoning, Dio 71,3,1; Hist. Aug. *M. Ant.* 15,5–6; Aur. Vict. *Caes.* 16.7.

[10] 23.6.24; IAP, 120.

2. Chronicle of Events[11]

165 Plague in the east at Nisibis and Smyrna
165/6 Plague brought back to Rome by army returning from the eastern campaign
166– Egypt: short-term land-leases disappear for a number of years, together with leases of large land-units[12]
166 Galen leaves Rome for Pergamum
167 Flight closes a funerary college in Dacian mining district, ending documentation there[13]
167/9 Annihilating losses due to flight or plague at towns in the Egyptian Delta
168 Plague in Rome and many provinces (Jerome)
168/9 Plague attacks the army at Aquileia, and the Emperors leave for Rome
168/9 Plague losses at Thmouis in Egyptian Delta by this date
172 Annihilating plague losses in the army (Jerome)
174 Traders in Puteoli appeal to Tyre for help, complaining of reduced numbers
174/5 Because of depleted numbers, Marcus Aurelius abandons the requirement for three generations of free descent in the Areopagus at Athens.[14]
179/80 Winter deaths at Soknopaiou Nesos in Egypt
182 Four members of the same family die of plague at Bedaium (*CIL* III 5567)
184 A Mithraic college at Virunum in Noricum meets 'mortalitatis causa'[15]
189 At Rome, the worst plague outbreak known to Dio.[16]
190–2 Mortality peaks in Lydian tombstones (5.1 below)

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[11] For most references in this section, see IAP, 116–7.

[12] See Section 4.1.

[13] The dated wax tablets in the mine galleries of Rosia Montana come to an end in 167 (Wilson 2012, 134 and 152; Russu 1975; Hirt 2010, 41–44, 192–6).

[14] IAP, 134. Marcus's letter also mentions that "many other cities had made claims for relief".

[15] After 5 out of 34 members had died, a meeting was held in June 184, apparently to mark the temple restoration completed the previous year, *ibid.*, 117 n.98, with Gordon 1996, 424–6.

[16] Dio 72,14, 3–4 but the original outbreaks took place in Dio's early childhood, n.4 above. In Herodian's account (1.12.1–2) the 189 occurrence strikes Italy as well, while in Dio it affects almost the whole Empire (he also refers to a scare about criminals infecting people with poisoned needles).

3. Diagnosis and Parallels

3.1. *Diagnosis*

Current research continues to identify the Antonine plague as smallpox.[17] This disease may confer some immunity on survivors, but its impact on a virgin population can be catastrophic.[18] A mean fatality-rate of 25–30% is sometimes suggested.[19] But inevitably there is regional variation.[20] Scott and Duncan report that "in individuals not protected by vaccination, the case fatality rate could be 15–25% overall, rising to 40–50% in the very young and the very old."[21] Children were particularly vulnerable: thus in Chester in 1774, 1385 cases of smallpox resulted in 202 deaths, 180 of them children.[22]

3.2. *Seasonality*

Cold winters and low rainfall were specially favourable to smallpox. This is shown by a detailed study of London deaths in 1659–1835.[23] In the plague at Aquileia in 168/9 "most of us died, not merely from the plague, but because the epidemic was happening in the depths of winter" (Galen).[24] And winter brought a heavy death toll in January and February 179 at Soknopaiou Nesos in Egypt (section 4.2).

3.3. *Parallels*

Epidemic outbreaks in China coincided quite closely with the chronology of the Antonine plague, probably pointing to a common origin.[25]

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[17] For convenience here called 'the Antonine plague'. See Zelener 2012; Harper 2017, 104–7 and 329 n.76.

[18] For example, nearly 2/3 of the population of Greenland (6,000–7,000 in all) died when the disease was first brought there in 1734 (Scott - Duncan 1998, 281). And some 18,000 out of 50,000 inhabitants of Iceland died in 1707 (170).

[19] Zelener 2012, 171. Littmann and Littmann 1973, 254 (pandemic rate).

[20] IAP 116, n.88.

[21] Scott - Duncan 1998, 170. For large numbers of child deaths, see also Dobson 1997, 478.

[22] Scott - Duncan 1998, 190.

[23] *Ibid.* 182 and *Table* 9.1.

[24] IAP 118, from Galen 19,17–18 Kuhn.

[25] IAP 117 *Fig.*1, with Morabia 2009. The duration was about the same, the China span from

China likewise shows a concentration of winter or spring deaths (February 173, March 182 and spring 179).[26]

4. A Case History: Egypt

Egypt provides the best case-study because of its unique documentation. Directly or indirectly, the papyri suggest a definite plague check.[27]

4.1. *Agrarian changes*

The first categorical evidence is the mention of victims of plague (*loimos*) in 167/9 at Kerkenouphis in the Delta. But there are clear signs of change before this date. One-year land leases had been frequent up to 165. But they disappeared from 166 to 182, leaving only leases of 4 years or more.[28] The land areas under cultivation shrank drastically, with nothing above 8 arouras leased from 166 to 191, in contrast to earlier peaks of 20 arouras and more.[29] Plague losses could make large farm-units more difficult to let, and they apparently drove out annual leasing as well.

These dossiers give a sensitive index of year-to-year change in rural Egypt. They follow the known chronology of plague very closely, with large leasing units only re-emerging from 192 onwards. There was a similar slump in short-term leasing after the Justinianic plague.[30]

4.2. *Population losses*

The number of taxpayers at Karanis in the Fayum seems to have fallen by 33–47% in the 25 years up to 171.[31] Elsewhere in the Fayum, at Soknopaiou Nesos, 59 of 244 males registered in September 178 died in January 179 and another

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161–85 being 4–5 years ahead (IAP 117–9, n. 102, with 115 and n.75 and *Fig.*1, p.117).

[26] IAP 118, n. 107. The epidemic might have originated in central Asia, *ibid.* 115 and n.75.

[27] For Egypt, see also the *Appendix* below, with notes 53 and 106.

[28] IAP 122, *Fig.*3.

[29] IAP 122, *Fig.*2. Money-rents also declined, 123 *Fig.*4.

[30] Banaji cited in Sarris 2007, 130, n.69.

[31] IAP 120 and n.113. Andorlini 2012, 21.

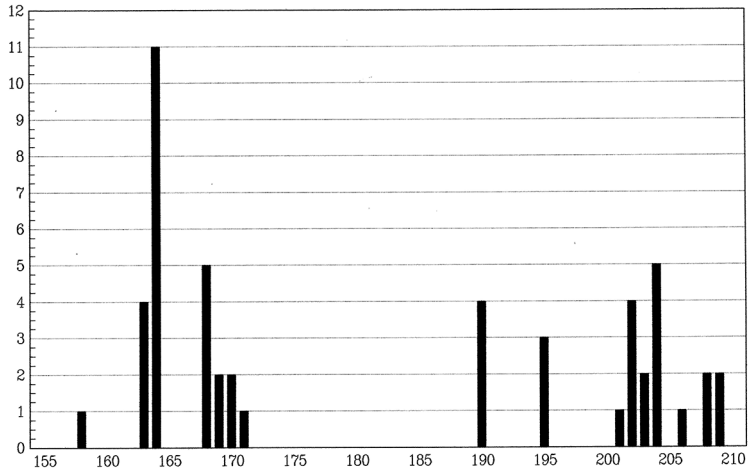

Fig. 1. Abrochos reports 155–210 CE.

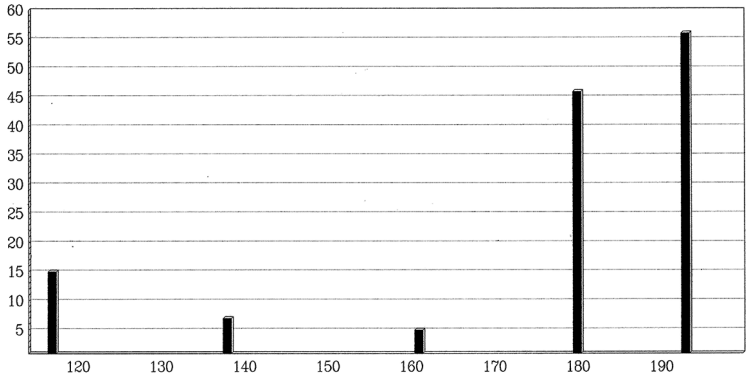

Fig. 2. Dating overshoot in days.

19 in February.[32] Losses at villages in the Delta between 159/60 and 167/170, at a time when plague was beginning its impact, were even greater. But they may have been partly due to flight.[33]

[32] IAP 121; Andorlini 2012, 22.

[33] IA 121 and *Table* 1. For flight, see also n.106 below.

4.3. *Bureaucratic decline*

Important change is also suggested by the reports of flood failure in Egypt (*abrochia*).[34] These reports reach their peak in 164, the year before the Empire's plague is first attested. Documentation then dwindles very rapidly in the late 160's, before disappearing completely from 172 (*Fig.*1). Reporting only resumes in 190, for one year, before ceasing again until 195. Plague probably returned in the early 190's (see Section 5.1). The long interruptions suggest a collapse in record-keeping during the plague period.

Bureaucratic deterioration emerges again in the recording of Emperors. News of an Emperor's death travelled slowly in Egypt, and dating by the old ruler might persist in some places after the new Emperor had been recognised elsewhere. Thus in 117 Trajan was still seen 15 days after the first Egyptian dating by Hadrian. Hadrianic dating in its turn lasted for 7 days beyond the first record of Antoninus Pius in 138. And dating by Pius in 161 still survived 5 days after the first record of Marcus Aurelius. These deviations were relatively small. But in 180, the first example after the arrival of plague , the excess suddenly leaped to 46 days, the gap between the first dating by Commodus and the last by Marcus Aurelius. This began a pattern of deterioration, with Commodus's Egyptian dating in 193 persisting at least 56 days after the first record of Pertinax (*Table* 4.1 and *Fig.*2).[35] Evidently recording and communications worsened considerably in the plague years. Egyptian documentation levels as a whole fell by one-third after 167.[36]

[34] For this evidence, Habermann 1997, and Bruun 2007, 205–6.

[35] The latest dating for Commodus is actually December 8th, 9 months after the first dating by Pertinax, O. Wilck 1976, But there were several would-be Emperors by then, and some Egyptians were now dating by Pescennius Niger, and others by Septimius Severus.

[36] Taking six-year averages within Marcus's reign, the 1996 dataset has 25.2 documents per year in 162–7; 16.0 in 168–73; and 15.8 in 174–9; IAP 125, *Fig.*7.

TABLE 4.1. Persistence of old dating after first news of the new ruler

	Year	New ruler first mention	Old ruler last mention	Overlap in days
1.	117	25 August	9 September	15
2.	138	26 July	2 August	7
3.	161	22 May	27 May	5
4.	180	14 April	30 May	46
5.	193	6 March	2 June	56

KEY Material located using Papyri.info, which also provides a checklist of editions of papyri and ostraka. Line 1: P. Oxy *3781;* IGRR *I, 1371. Line 2:* OBerl *53 ;* SB *1, 1669. Line 3:* OWilck *245;* OLeid *139, Line 4:* PPrag *1, 63;* OLund *inv 17, Line 5:* Chr.Wilck. *490;* Chr.Wilck *268.*

5. Mortality Patterns

Across the Empire archaeologists have uncovered a large number of mass burials from the Roman period, and many examples have been collected in an important recent survey.[37] Some may well belong to the Antonine Plague, but no specific identifications yet seem to be possible. However, dated tombstones offer material from the plague period, which contains revealing patterns (5.1).

5.1. Local Chronology: Lydia

Roman burials in north-east Lydia have left over 600 tombstones dated by year.[38] *Table* 5.1 analyses forty years of these tombstones, from 160 to 199 (*Fig.*3). Their dates show three periods of higher mortality, amounting to 14 years (*Table* 5.1 section A). Here the death-rate is 6.36 per year on average. That falls to 2.92 in the 26 years of low mortality. Thus the burial rate more than doubled in unhealthy years.

[37] McCormick 2015 and 2016. For an early example from Rome, Blanchard, Castex 2007.

[38] Broux - Clarysse 2009, 29. *Fig*.3 is re-drawn from the authors' data by kind permission. Some tombstones are from Saittae (Sidas Kale), a town large enough to boast a stadium, and later a bishop.

TABLE 5.1. Lydia: dated tombstones CE 160–199

A. Periods of raised mortality:

	Total	Duration in years	Tombstones per year
165–170	42	6	7.0
182–183	16	2	8.0
189–194	31	6	5.2
Aggregates	89	14	6.36

B. Periods of lower mortality:

160–164	12	5	2.4
171–181	31	11	2.8
184–188	17	5	3.4
195–199	16	5	3.2
Aggregates	76	26	2.92

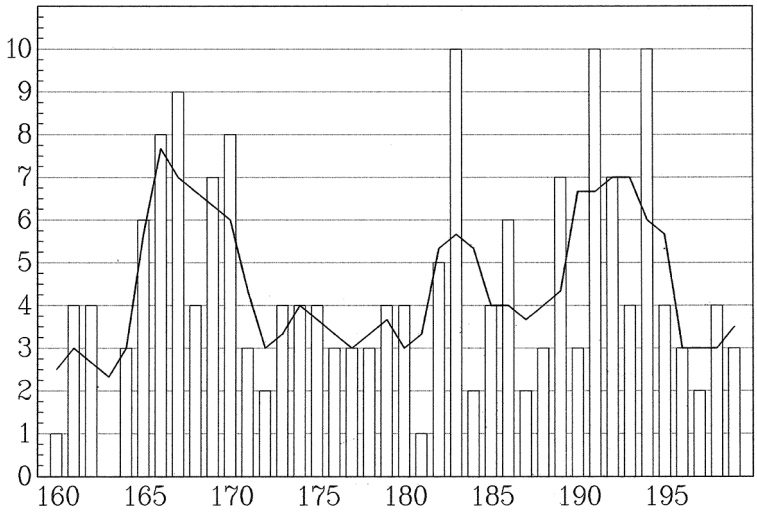

Fig. 3. Lydia tombstones 160–199 CE.

That produced about 45 additional deaths.[39] The aggregate increase is 27% (45/120), roughly one-quarter, over the forty years in question. But like most Roman tombstone evidence, this sample mainly describes adult mortality. In parallel evidence, child mortality from smallpox was far above the adult figure (see Section 3 at n.21).[40] Thus many cases are presumably missing. Overall raised mortality of well over one-third is probably suggested here.

The three-year moving average (shown as a line in *Fig*.3) suggests a major mortality peak in the late 160's, followed by a short peak in the early 180's, with a second main peak in the early 190's (*Fig*.3). In fact the sequence echoes the pattern of severe outbreaks at Rome in the late 160's and from 189 onwards. This evidence from a relatively distant part of the Empire thus suggests that the plague was also active there.

6. Social Impact of The Plague

6.1 Slaves

The Antonine plague, like epidemics in general, evidently hit slaves very hard. Their living conditions were harsher, sleeping arrangements were often communal, and nutrition was inevitably inferior. Galen records that the plague killed almost all his slaves in Rome (n.8 above). Aelius Aristides reports that a plague infected almost all his neighbours at Smyrna in the summer. First two or three of his servants grew sick, then one after another. Then all were in bed, both the younger and the older. Aristides was the last to be attacked. "And if anyone tried to move, he immediately lay dead before the front door."[41]

Parallels are provided by Dionysius and Livy. In 451 BCE a plague at Rome killed all the slaves and half the citizens.[42] An outbreak which had begun the year before with cattle disease affected country-dwellers and slaves in 428, before spreading to the city. The plague visitation in 174 BCE, after attack-

[39] Taking mortality in the low years as 3 (2.92 in *Table* 1), section B produces a baseline of 120 expected deaths over 40 years. Actual deaths total 165, an excess of 45.

[40] A very few tombstones show two individuals. But the additional cases have not been utilised here, because it is not clear whether a shared tombstone always meant contemporary deaths.

[41] Aristides quoted in IAP 118.

[42] Dion. Hal. 10,53.

ing cattle the previous year, spread especially to slaves, whose unburied bodies lined the roads.[43] In the Renaissance period, more than half the plague deaths in Cairo in 1419 were deaths of slaves.[44] And in an early modern parallel from 1815, bubonic plague at the town of Noja in Apulia at first struck only the poor.[45]

Slaves remain artificially rare in ancient narratives. But Galen and Aristides clearly show their special vulnerability at times of plague, and that is echoed by the Roman annalists. Thus a severe epidemic would probably disable or wipe out much of the labour force. When his own slaves were afflicted, Aelius Aristides was reduced to being waited on by slaves of the doctors who had come out to attend him (n.41).

6.2. The Army

The dangerous potential of a large standing army for spreading epidemic under pre-modern conditions is obvious.[46] Movements due to war mobilisation, transfer of units, and furlough of individuals left great vulnerability to the spread of disease.[47] In fact the sources single out the plague's extreme impact on the army.[48] Jerome claims that the army was almost reduced to extinction in 172. For Eutropius whole armies died, and almost all the armed forces fell victim to disease, as well as many people in Rome, Italy and the provinces. Orosius makes the impact on the legions in winter quarters so great that a 3-year conscription drive at Carnuntum was needed for the war with the Marcomanni. The *Historia Augusta* states that many thousand soldiers died.[49] The biographer also adds that

[43] Liv. 4,30,7–11; 41.21.5-11.

[44] 1913 out of 3683, Dols 1975, 178, 180–1 (IAP 113, n.44).

[45] Post 1977, 133.

[46] Eck 2012, 65.

[47] For movement of individual soldiers, Duncan-Jones 1994, 83–4.

[48] Gilliam mentioned this chorus of disaster, but set it against Tertullian's optimistic words from across the Mediterranean, which are not about the army (Gilliam 1961, 231–4). But for Africa as a partial exception at this time, see IAP 128–9 and *fig.*12, together with Duncan-Jones 2004, 33–35, with *figs*.3 and 4.

[49] *M.Ant*. 17,2.

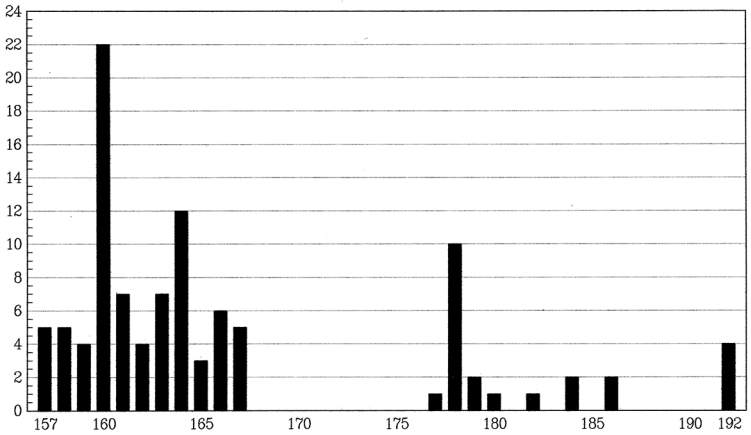

Fig. 4. Army diplomas 157–192 CE.

Marcus, as well as raising fresh recruits for the legions, even recruited soldiers from slaves, gladiators and bandits, as well as mercenaries from Germany.[50]

These last details come from one of the strong lives in the Historia Augusta.[51] Army inscriptions also indicate drastic upheaval. In particular, a list of legionaries discharged from VII Claudia in Lower Moesia in 195 implies that the 169 intake was much larger than usual. The total of 270 survivors is at least twice the expected number, after allowing for deaths in service.[52] And a legionary inscription of 168 from Alexandria shows heavy reliance on men born in the camp, among soldiers recruited to II Traiana. Earlier lists indicate recruiting from named cities.[53] The change suggests significant shortages of men from the normal recruitment zones at this time.

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[50] Hier. 206 Helm; Eutr. 8,12,2; Oros. 7,15,5–6; Hist. Aug. *M. Ant*, 21,6. For 'voluntarii', see Duncan-Jones 2016, 137. The recruitment of volunteers for a specific campaign is seen at Thespiae in Boeotia in 169/72. They were mainly non-citizens (Jones 2012).

[51] Chastagnol calls the biography "honorable mais désordonée" (Chastagnol 1994, 111–119). See also Stover, Kestemont 2016.

[52] Eck 2012, 68–70; Strobel 1988. Mirkovic 2004 provides the fullest tally, but see also Eck 2012, 68 n.35.

[53] Duncan-Jones 1990, 72 and n.40.

Other army documents reflect plague changes in a dramatic way. The discharge-certificates (*diplomata*), although plentiful up to the mid-160's, stop completely after 167, until resuming with a single example in 177 (*Fig.*4).[54] The new figures make the pattern even more vivid, with pre-plague totals reaching 22 in 160 and 12 in 164.[55] The sudden cessation (4.3 above and *Table* 6.1) suggests collapse in army documentation during the plague years, possibly exacerbated by metal shortage due to mining problems (see 9.1 below; for mining and quarrying, see also *Table* 7.1 below).

6.3 Individual deaths

(i) Aquileia was in the war zone from which the two Emperors rapidly escaped in 168, driven out by the plague, in Galen's account (n.9 above). Their retinue evidently included M.Servilius Fabianus Maximus. Consul in 158, Fabianus had substantial military experience, as governor of each of the Moesias. At least four members of his household who died at Aquileia were presumably plague victims.[56] They were Fabianus's Greek doctor and friend, Sergius Hestiaeus, his slave doctor Phoebianus, his freedman Trophimus and his slave masseur Naisus (the last three were all buried by "Fabianus consularis").[57]

(ii) The sisters Cornelia Procula and Cornelia Placida buried their father Cornelius Rusticus Senecio at Rome, together with his son. Senecio had been proconsul of Asia under Marcus and Verus, with his son as legate.[58] Father and son were apparently buried at the same time, as Dessau commented. Simultaneous burial might imply plague deaths.

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[54] From Eck 2012, 71. Eck's chart is re-drawn here by kind permission.

[55] The earlier summary, from Roxan 1985, has much lower totals (IAP, *Fig.*6, p.124). The unconvincing view that the recording cessation after 167 merely reflected changed conditions of service after CE 140 is discussed in Eck 2012, 70, n.40.

[56] *PIR*^{2} S 583; Duncan-Jones 2016, 192, no.333.

[57] *IGRR* I 482, *CIL* V 868–870; *PIR*^{2} S 583 and 523, with discussion.

[58] *ILS* 1089–90; *Dig*. 48,18,1–4. For apparent repercussions of the plague on senatorial office-holding, see Duncan-Jones 2016, 64.

(iii) A younger senator, Q. Julius Maximus, died in mid-career.[59] His service as legate to the proconsul of Narbonensis was relatively modest, but Maximus was about to achieve importance as praetor. He was buried at Ebora in Spain aged 46 with his sons, Clarus and Nepotianus, both vigintiviri, aged 20 and 21. He was buried by his wife. Most aristocratic tombstones do not give ages. Together with the triple death, that may suggest a plague event.

(iv) M. Macrinius Avitus Catonius Vindex came from the equestrian militiae, but rose high in the Senate, governing the two Moesias in succession, like Servilius Fabianus. He also held one of the highest priesthoods, as augur.[60] He died aged 42 years and 5 months. Age statement for a senator remains unusual, and may again imply a sudden event.

(v) At a more modest social level, Julius Victor buried his parents, wife and daughter who had died "per luem" at Bediaium in Noricum in 182. Also buried was his 30-year old brother Aurelius Iustinus, who had served 10 years in legio II Italica.[61]

7. Dating Interruptions

7.1 The plague hiatus

Dated series often show a long gap at the time of the plague. This normally starts in the middle or late 160's (*Table* 7.1). Three series, British lead mining, marble quarrying at Teos and records in the Dacian mines (nos.3, 4 and 5), did not resume after the break as far as we know. That suggests a catastrophic impact on mining and quarrying operations.[62] In Italy plunder of existing monuments for their marble began as early as 202/10 CE.[63] Other examples in *Table*

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[59] *PIR*^{2} I 424; Duncan-Jones 2016, 195, no.476.

[60] Vindex was the only senator from the militiae to hold such a high priesthood in the database in Duncan-Jones 2016 (11, *Table* 2.3 gives totals). His success may have owed something to the Vindex who was praetorian prefect in 172 (*ILS* 1107; *PIR*^{2} M 22; Duncan-Jones 2016, 197, no.525).

[61] Chronicle, Section 2 above, and *CIL* III 5567.

[62] For mining, see 9.1 below, with Mattingly 2011, 170.

[63] Papi 2004, 57; the examples include a dedication to Septimius Severus at Veii engraved on the

7.1 probably suggest communication breakdown, as in the worsening delays revealed by Emperor-dating in the papyri (4.3 above).

TABLE 7.1. Gaps in dated series

Series	Cessation after	Resumes in	Gap in years
1. British lead ingots	164/9	-	-
2. Dokimeion marble	164	173	9
3. Mauretania Caes. dated inscriptions	164	182	18
4. Egyptian short-term leases	165	183	18
5. Lease-areas above 8 arouras	165	190	25
6. Teos marble quarry	166	-	-
7. Dacian wax tablets	166	-	-
8. Rome inscriptions with exact dates	166	179	13
9. Army diplomas	167	176	9
10. Mons Balcaranensis: Saturn dedications	167	175	8
11. African inscriptions with exact dates	168	180	12
12. Egyptian abrochos reports	172	189	17

REFERENCES. 1. IAP 121, n.118; 2. Fig. *5 below with Hirt 2010, 370–402; 3. IAP 129, n. 148; 4. IAP 122,* Fig. *3; 5. IAP 122,* Fig. *2; 6.Hirt 2010, 402–9; 7. See n. 13 above; 8. IAP 125–6 with* Fig. *8; 9. See Section 6.2 above with* Fig. *4; 10. IAP 129, n. 148; 11. IAP 129, n.148; 12. Section 4.3 above with* Fig. *1.*

7.2 Tomb-building at Palmyra

Over a hundred dated tomb-inscriptions have survived from Palmyra, the remarkable caravan city on the Empire's eastern fringe. They span a period from 9 BCE to 265 CE.[64] Until 160, they always refer to newly-built tombs.

back of a dedication to Tiberius.

[64] Marcone 2001, 812. Gawlikowski's inventory shows 112 tombs with dates translated into the Julian calendar. A further dated item can be added (Gawlikowski 1970, no.5, 185, 'year 345' or

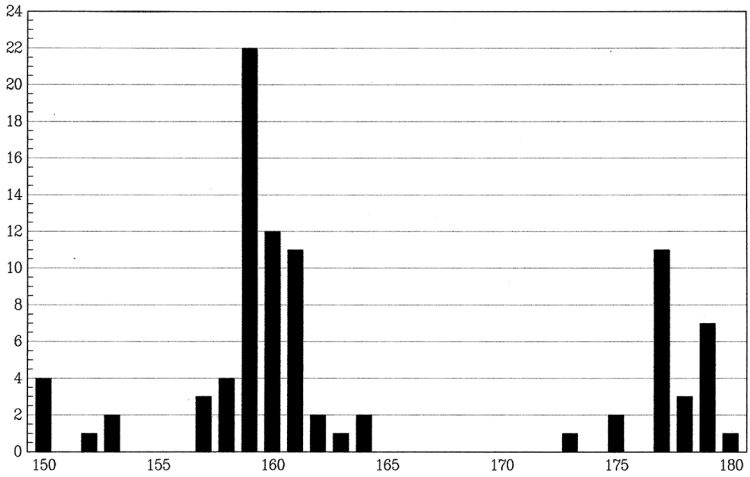

Fig. 5. Dokimeion marble 150–180 CE.

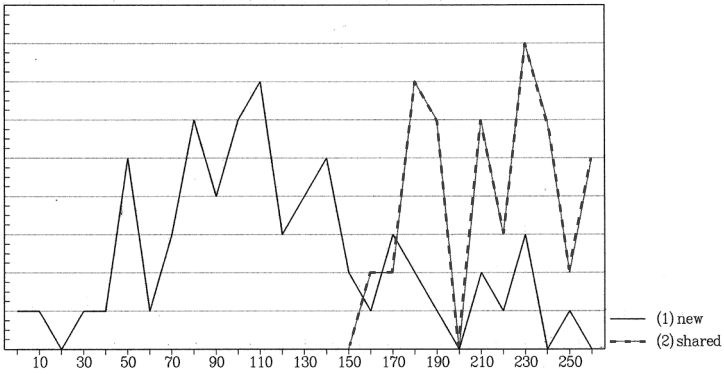

Fig. 6. Palmyra tombs 1–260 CE.

But two inscriptions from that year show sharing arrangements, where the owner of an existing monument made over a defined section to another party in perpetuity. Thus in October 160, the two builders of a hypogaeum ceded part

34 CE). All the inscriptions have a text in Palmyrene, while those in the earlier set often include a parallel text in Greek.

of it to Hadudan, son of Salman, son of Zabdibol, and his children and grandchildren.[65]

This was apparently a novelty, since the previous dated tomb-inscriptions all refer to new monuments. The transition period of the 160's and 170's contains four examples of each type. But new monuments then became rare, and shared tombs predominated for the rest of the period (see *Fig.*6). Thus the Palmyra tomb-inscriptions fall into two distinct phases, with a transition at about the time when plague struck the Empire.

The shift in burial practices may simply be a cultural change. But the partial coincidence with the plague period at least suggests pressures to spend less on interment at that time.[66] The cessation of both dated series soon afterwards for almost twenty years (from 194 to 213) may also show a response to external conditions. Less costly burial after the plague period probably implies economic adversity. There is little or no documentation of the caravan trade between 161 and 193.[67]

8. Reaction to the Plague: Oracles and Amulets

Lucian mentions the plague in a hostile account of his contemporary, the prophet Alexander of Abonouteichos. He writes that to protect people, Alexander composed an apotropaic Greek verse invoking Apollo. But Lucian says it gave no protection, leaving its users just as likely to catch the plague as anyone else.[68] Part of the wording recurs on a Roman pewter amulet discovered in London in 1989. This amulet also invokes other deities. Its text is in Greek, but it may have been made in Britain.[69]

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[65] Gawlikowski 1970, 205, no.2.; no.1 is a parallel from November 160.

[66] In its classic version, the Palmyrene way of death included tombs of some grandeur, whose numbers would hardly increase at a time of epidemic..

[67] Smith 2013, 79–80.

[68] Lucian, *Alex*. 36, quoted in IAP, 119.

[69] Tomlin 2014. Apparently the text also discouraged mouth contact by the user (Jones 2016). The amulet's owner was called Demetrios. For plague impact in Britain, see also Hingley 2018; Perring 2011, 279–80; Simmonds *et al.* 2008, 140–1.

Similar appeals for divine help were made all over the Empire. Greek inscriptions from Pergamum in Mysia, Caesarea Troketta in Lydia, Kallipolis in the Thracian Chersonese, and Hierapolis in Phrygia prescribe programs of sacrifice and invoke Clarian Apollo as the one who drives away the epidemic.[70] And simple formulaic Latin inscriptions invoke the gods and goddesses "following the interpretation of Clarian Apollo".[71] These come from Britain (again), Sardinia, Dalmatia and Numidia. Another three are from Italy and two from Mauretania Tingitana.

This remarkable dossier in Greek and Latin suggests widespread fear of a threat against which Clarian Apollo was considered the great safeguard. The plague was not necessarily prevalent wherever the texts are found. But, like Lucian's anecdote, they show a compelling desire to take precautions. Their very wide distribution recalls Ammianus's statement that the plague spread from the frontiers of Persia all the way to Gaul and the Rhineland.[72]

9. Climate and Environment

9.1. Environmental impact: tree-felling and mining

Identifying Roman short-term climate trends does not yet seem possible.[73] But tree-ring chronology in central Europe has now revealed very wide fluctuations in the rate of tree-harvesting. The 7,284 examples come from north-eastern France, north-western Germany and south-eastern Germany. A peak early in the second century CE, is followed by a very sharp collapse, then by two partial recoveries in mid-century. A further extreme collapse followed in the 170's, 180's

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70 Faraone 1992, 59–61. Jones 2016; Harper 2017, 328, n.68. For a similar appeal to Artemis as a bulwark against plague at another Anatolian town, Graf 1992. Despite Lucian's evidence, now echoed in London, Gilliam was reluctant to associate these texts with the Antonine plague, and overlooked the related Latin series (Gilliam 1961, 234–6).

71 "*secundum interpretationem Clari Apollinis*". These inscriptions probably belong to the time of the Antonine plague; (Jones 2005, 2006 and 2016).

72 23,6,24.

73 Manning 2013 provides a stimulating discussion of the complexities and contradictions of the evidence. The diagrams show long-term rather than short-term change.

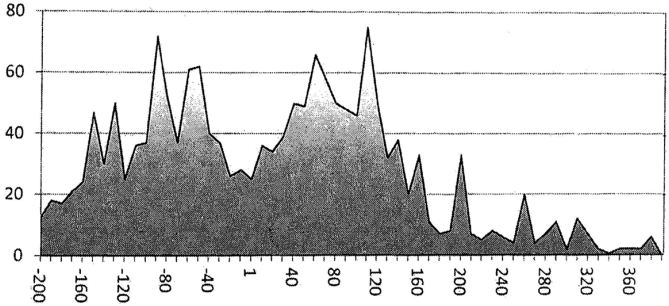

Fig. 7. Forest clearance in central Europe (Germany, North-Eastern France).

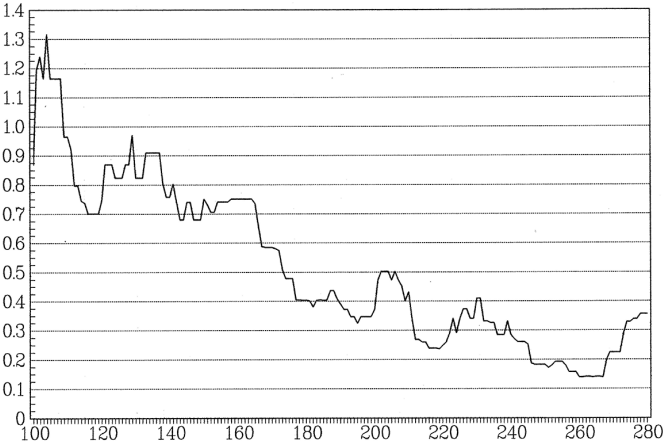

Fig. 8. Lead pollution 100–280 CE.

and 190's, before recovering in the 200's. (*Fig.*7).[74] The sharp decline in tree-felling during the main plague period suggests sudden change It implies reduced building and construction activity in these regions, and possibly less demand for wood and charcoal.[75]

[74] The diagram is reproduced by kind permission from Malanima 2013, 28, *Fig.*4. This provides a smoothed version of the analysis by decade in Buentgen *et al*. 2011, 580, *Fig.*2, line C.

[75] Malanima 2013, 27.

The impact on silver mining was evidently more drastic. An arresting new study of Greenland ice-cores shows a dramatic fall in European lead-pollution at the time of the plague. (*Fig.*8) The authors conclude that "the Antonine plague marked the turning point between high levels of lead-silver production during the Roman Empire period, and much lower levels observed from the mid-second century until the mid-eighth century. The plague disrupted mining through high mortality in, and flight from, mining regions, and reduced demand through population loss."[76] This dramatic record reflects the impact of the plague on the European environment, and is probably the most graphic demonstration so far.

9.2. Climate forcing and plague

The biggest volcanic emissions can darken the skies and affect the weather.[77] Pliny's account of stumbling round Misenum in total darkness during the daytime provides an obvious illustration.[78] Volcanic fallout may also lower long-term temperatures significantly, and even create artificial winter. A spectacular case is the gigantic eruption at Tambora in Indonesia in 1815, which led to a "year without summer" in 1816.[79] Its effects were felt as far away as Europe, and throughout much of the world.[80]

Cassius Dio's account of the great eruption of Vesuvius in CE 79 states explicitly that the ash brought a terrible epidemic in its wake.[81] "An inconcei-

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[76] McConnell *et al.* 2018. *Fig.*8 shows the estimated lead emissions for CE 100–280, with an 11-year median filter. Drawn from data kindly supplied by the authors; the unit is kilotonnes per annum (kt/a). .

[77] Stothers - Rampino 1983b; for revised eruption dates, see now Sigl 2015. Dust-veil phenomena in the lower atmosphere may also be generated by relatively small volcanic events, Grattan - Pyatt 1999; Post 1977, 3–6.

[78] "*Vix consideramus, et nox non qualis inlunis aut nubila, sed qualis in locis clausis lumine exstincto.*" "We had scarcely sat down when darkness fell, not the dark of a moonless or cloudy night, but as if the lamp had been put out in a closed room"; from his account of the Vesuvian eruption in CE 79, *epist.* 6,20,14.

[79] Wood 2014.

[80] Earlier mammoth eruptions that affected Europe and the Middle East in 536, 934 and 1258 have also been detected as far away as Mongolia and northern Siberia, using tree-ring evidence, d'Arrigo 2001; the tenth-century event is dated to 939 by Sigl 2015.

[81] Dio 66,23,5. It is now known that deadly fallout from this eruption extended far beyond Pompeii

vable quantity of ash was blown out, which covered both sea and land and filled all the air. It caused much injury [...] to men and farms and cattle, and in particular it destroyed all fish and birds. Furthermore, it buried two entire cities [Pompeii and Herculaneum] [...] Indeed the amount of dust [...] was so great that some of it reached Africa and Syria and Egypt, and it also reached Rome, filling the air overhead and darkening the sun […]. These ashes did no great harm at the time, but later brought a terrible pestilence."[82] Latin writers describe this plague as one of the worst that there had ever been.[83]

Thus a violent eruption was followed by widespread epidemic. Volcanic darkening which lowered temperatures could also increase vulnerability to infection, through reduced crop-yields and widespread malnutrition.[84]

The eruption in a second case was even more potent, although too distant for the event to be directly observed in the Mediterranean. But its effects were seen there as a sign of world-shaking change, because it took place in 44 BCE, the year of Caesar's assassination.[85] Plutarch relates that the sunlight grew pale and watery, lacked its usual heat, and prevented the fruits from ripening because of the coldness of the atmosphere.[86] Evidently this was one of the veiling effects that reduced daylight and daylight temperatures.[87] Powerful corroboration comes from the ice-core and tree-ring evidence, which points to this being one of the three biggest eruptions of the last 2500 years.[88] Sulphate deposits in

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and Herculaneum. At Positano, 20 km away, a remarkably well-preserved first-century villa has recently been revealed beneath the main church (Jacobelli *et al*. 2017; Cinque 2009). Other distant villas were engulfed at Amalfi, Maiori and Vico Equense (Ianelli in Jacobelli 13). The eruption was evidently gigantic, and its signature in the global record has been identified by recent ice-core studies (Barbante 2013).

82 Dio 66,22,2; 66,23,1.

83 Suet. *Titus* 8,3; Epit. de Caes. 10,13.

84 For the mechanism, see for example Rossignol 2012, 95–103; for the eruption dates, see now Sigl 2015. For the cooling effect, Kondratyev 1988, 122.

85 Stothers 2002, 17.3. The eclipse claimed at the death of Augustus in CE 14 was equally opportune, but may not be genuine, Dio 56,29,3; Stothers 17.3 – 17.4.

86 Plut. *Caes*. 69,3–4; Stothers and Rampino 1983a, 6358.

87 See n.77.

88 Sigl 2015, *Extended Data Table* 4, giving the likely source as 'Chiltepe?\Nicaragua'.

Greenland reached almost the highest recorded level, and northern cooling registered by tree-rings was among the most drastic in the entire period.[89]

The following year a serious epidemic affected the whole of Italy (43 BCE). In response, the Senate tried to appease the gods by re-building the Curia Hostilia.[90] Thus the mechanism of darkened skies leading to reduced temperatures followed by epidemic, also operated here. This syndrome emerged again in the volcanic dust-veils and extreme winters that preceded the great plague of Justinian in 541–2.[91]

While great epidemics need not depend on volcanic darkening, these episodes remain very striking, and their mechanism may be relevant to the Antonine plague. No volcanic prelude is known for the plague outbreak in 165. But that appears to have changed with a massive eruption in 168/9.[92] This left a heavy sulphate deposit in the Greenland record (39.1), and had a noticeable cooling effect (estimated as the 14th coldest of 23 extreme cases over two millennia). Since the plague was certainly still active in 170–2 (Chronicle, Section 2 above), volcanic climate forcing at this time might well have increased its impact. The eruption was strong enough to affect the southern hemisphere as well, with a sulphate deposit of 18.4 in Antarctic evidence, and overall global forcing of -11.5. Overall, the northern sulphate deposit makes the 168/9 event 15th largest out of 25 cases in 2500 years.[93] Thus the eruption was certainly of great size.

Italy experienced darkened skies followed by general epidemic both in 44/3 BCE and in CE 79/80. The eruption in 168/9, which had global effects, may be a further case, which intensified and prolonged the epidemic that already threatened the Roman world.

10. Conclusion

Plainly there can be reluctance to admit epidemic to the pantheon of major historical events, even if a catastrophe like the Black Death is recent enough and

[89] The N-Tree score was -3.33, Sigl, *ibid.*

[90] Dio 45,17,8.

[91] Sigl 2015, 7–8. Harper 2017, 217–9, 224–30.

[92] Sigl 2015 *Fig.*2 and *Extended Data Set Table* 4.

[93] Estimated cooling of -0.94 C in relation to averages of 1961–90.

violent enough to be beyond dispute. Some respected accounts of Roman history choose to ignore epidemics. Gilliam drew attention to the silence of Gibbon and Rostovtzeff. Even Thucydides' first-hand description of the Athenian plague has not always been believed. Nevertheless, an even-handed approach to the Antonine plague has to consider the available evidence and judge accordingly.

This survey begun in 1996 set out to test the literary evidence, much of it written centuries afterwards, against the contemporary data. Proxy sources are not usually explicit, and may be affected by extraneous stimuli.[94] But here their main chronologies converge, suggesting a major check. Combined with the explicit written tradition, they make up a powerful dossier (Sections 4–9.1). Fresh documentation reinforces the evidence of dislocation during the plague period. Thus Galen proves to have lost most of his slaves in Rome, showing again the special vulnerability of slaves to epidemic.[95] In Lydia dated tombstones closely mirror the plague peaks seen in Rome (5.1). The evidence of crisis in Egyptian record-keeping continues to grow;[96] and the much larger sample of diplomas has added to the picture of army disruption. The Dokimeion marble quarry has produced further evidence of a check. Most graphic of all are the new indications of collapse in silver mining (9.1) Another recent study suggests a sharp decline in northern tree-felling during these years, while a third may indicate that volcanic climate forcing increased the effects of the plague. [97]

Some evidence also suggests unevenness in the plague's impact. In particular, the African provinces show continued public building activity in inland cities, and growing volumes of pottery production (n.48). But this still seems to be qualified by long interruptions in the African coastal series during the plague years (*Table* 7.1, lines 3 and 10). Thus even the southern zone outside Egypt probably did not escape unscathed. The strongest new indication of the plague's strength is the evidence about mining (*Fig.*8 and n.76).

Gonville and Caius College, Cambridge

[94] The *Appendix* considers one alternative diagnosis.

[95] See n.8 and Section 6.1.

[96] Section 4.3.

[97] Section 9.1.

APPENDIX. Second century climate

In discussions of Roman climate, increasing reliance has been placed on Egyptian evidence.[98] Flood assessments have been used as a source for climate trends.[99] Climate changes should be distinguishable from short-term events such as plague, but dependence on proxy measures means that the two can be confused. That makes the flood estimates potentially relevant here.[100] Nevertheless, Egypt specialists have doubted whether seemingly explicit data, the local coin legends giving the flood's height as 16 cubits, refer to a historical event rather than an ideal state. Johnson wrote: "whether or not these were commemorative cannot be decided […] there is no evidence that good crops were characteristic of these years."[101] But Bonneau took a different view in her 1971 study, adding inferences from the papyri.

This calls for some comment.

1. There is very little direct information about the height of the annual flood before the Arab period[102]. Estimates for the Roman period depend almost entirely on proxy data, either coin-motifs or agrarian details from the papyri.[103]

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[98] See for instance McCormick *et al.* 2012, 183, 189, 194; McCormick 2013, 71, 76–81; Wilson 2013, 264–6; Elliott 2016; Harper 2017,15, *Table* 1.1, and p.133. A deterioration in climate from about CE 155 has been suggested.

[99] But the Nile flood was driven by the amount of rainfall in Ethiopia (McCormick *et al*. 2012, 183). Conditions in the Mediterranean and further north may follow other patterns.

[100] Bonneau 1971.

[101] Johnson 1938, 17. The 16-cubit archetype emerges repeatedly. Thus it is seen in the multiple offerings of 16 identical objects to the Nile god (*P. Oxy*. 1211), in Pliny's account of the optimum flood level (*NH* 5,58), and in the celebrated statues of the Egyptian river-god with 16 putti (cherubs) playing round him (*NH* 36,7; Haskell - Penny 1981, 272); Bonneau 1964, pl.5 and p.520; see also Bonneau 1971, 50. But on coins the 16-cubit motif is fairly rare, and its appearances suggest short-term stylistic choice rather than hydraulic bulletins. They are concentrated in three very brief periods: CE 98, 100, 108 and109; 127 and 128; and 143, 144, 145, 147, 148, 150 (Bonneau 1971, 238–247).

[102] For figures from CE 622 onwards, see Kondrashov, Feliks, Ghil 2005.

[103] The stone list of favourable flood readings for the Roman period from Elephantine is so badly damaged that only a dozen cases out of 35 combine an intact flood figure with a complete date: Johnson 1938, 16; (*IGRR* I 1290 = *SB* 8392; Bonneau 1971, 29–31, 156 n.759). Elephantine was a

2. The amount of data fluctuates considerably. The decades for which Bonneau gives continuous estimates are 90–169, 200–209, 230–239, and 240–249. The amount of evidence shrinks in 170–99, that is, for most of the plague period, as well as in the later third century.[104]

TABLE A.1. Flood estimates from coin evidence only (Nilus motif)

Flood score	Occurrences
4/4?	7
No score	17
Query	6
TOTAL (years)	30

TABLE A.2. Flood estimates that include other data (Nilus motif)

Flood score	Occurrences
1	2
2	9
3	5
4	12
5	4
7	3
8	3
TOTAL (years)	38

NOTE TO TABLES A.1 & A.2. Bonneau's 8-point flood scale ranges from M (mauvaise) up to Fo (forte). These eight steps can be more easily understood as numbers.[105] The results, with Bonneau's estimated figures for the flood-height at Memphis read: 1. mauvaise (under 8 cubits); 2 faible (8–10); 3 médiocre (10–12); 4 normale (12–14); 5 bonne (14–16); 6 trés bonne (16); 7 abondante; 8 forte.

long way up the Nile, and the figures range from 24 to 26 cubits, placing them far above the traditional 16-cubit optimum (n.101) down river at Memphis (Bonneau 1971 50).

[104] The years missing at this point are: 172, 173, 175, 178, 179, 182 and 193 (Bonneau 1971, 250–252).

[105] Also McCormick 2013, 77, n.44.

3. Bonneau's inferences from the coin-motifs in her final Tableau are varied, although they are often left incomplete. The coin-motifs are taken as expressly meaningful, with their absence signifying a poor flood (years 129,130, 151, 163). The Nile type, mainly second and third century, is much the most frequent. Here the coin-evidence on its own yields a flood score of about 4 in half a dozen cases. But it usually provides no reading whatever (in 23 cases out of 30, *Table* A.1; with Note for the index figures). However, when juxtaposed with other evidence, the Nile motif can apparently mean almost any flood-level (*Table* A.2 with Note). Yet if it celebrated the current flood, why should it also occur in years when the flood is estimated as very low?

4. The material from the papyri (*Table* A.2, and many further cases without coin evidence) is rarely explicit enough to mention the flood. In most cases, a reading can only be obtained by treating almost any agrarian bulletin as if it contained flood data in coded form. The explicit flood figures in a well-known inscription provide a robust starting point (n. 103). But the dated examples there are very few, and the estimates of the flood-level from indirect evidence mostly seem inconclusive, despite the apparent precision implied by an eight-point scale (*Table* 8.2). And there are other uncertainties. For example, did the taxpayers who were driven to flee their villages do so because of adverse flood conditions, or because of an over-harsh tax-regime?[106]

5. It is reasonable to ask whether the coin-motifs contained flood information at all. A well-known authority has doubted this (n.101). The river Nile certainly possessed its own cult from time immemorial.[107] That should explain the use of Nilotic motifs on the coins without the need to look further. Most people using the coins already knew the state of the flood, as the heavy Alexandrian coinage did not circulate outside Egypt. Nevertheless, Egyptians presumably liked to see the river god celebrated there.[108] To modern eyes, the coin-type referring to

[106] For taxation, Adams 2004, 101. In the Roman period, flight is indicated in Bonneau's list in the years 19, 43, 53, 54, 55, 102, 132, 133, 136, 137, 138, 140, 141, 142, 143, 144, 146, 149, 156, 159, 166, and 168 (Bonneau 1971, 234–250). Unsurprisingly, this series ends early in the plague years, suggesting recording breakdown; see Section 4.3 above.

[107] Bonneau 1964 examines this important cult in great detail (219–360).

[108] "The Alexandrian coin-types give the impression that the mint officials...at times of pressure

a 16-cubit rise may look like a clear-cut flood bulletin. But for Egyptian contemporaries, the number seems to have been essentially a cherished stereotype (n.101).

6. Disappointingly, the estimates of the Nile flood probably offer little basis for reading climate trends in Egypt. In all likelihood the flood varied as much in the classical period as at other times (n.102). But with a few tantalising exceptions, records from the Roman period do not seem to document its behaviour. Thus the climatic recession in the mid-second century that has been posited from modern interpretations of Nilotic evidence seems unclear. If Egyptian climate trends are uncertain, they can hardly explain other changes. Where serious dislocation is seen in Egypt at this time, it remains more convincing to think that it reflects the current epidemic.[109]

used the stock designs." Milne 1933, p.xl. For the predominance of standard religious motifs over 'message' motifs in mainstream Roman coinage, see Duncan-Jones 2005, 470–1.

[109] For the Egyptian evidence, Section 4, with notes 53 and 106.

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