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Supplementary Information for

The Justinianic Plague: An inconsequential pandemic?

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Materials and Methods

Fig. 1
The spatiotemporal contours of outbreaks are all summarized from Stathakopoulos' catalog (*1*). The authors read and analyzed every historical text listed in the catalog, and considered how the sources that mention plague described it. All these texts were compiled during and after the 6th century; many of them are non-contemporary, written sometimes more than a hundred years after the events they describe. We removed a few from consideration, since they did not directly discuss an epidemic. In contrast to Stathakopoulos, we did not include epigraphic (inscription) evidence since we discuss this type of data elsewhere, and it is, for the Justinianic Plague and first plague pandemic, indirect and rather inconsequential. Likewise, we did not include the modern secondary research Stathakopoulos listed in place of some Arabic texts because it is qualitatively different from ancient texts. Finally, we did not include the Arabic texts written centuries after the events they describe because of their complex and under-researched transmission and connection to plague (e.g. several sources copy the same plague episode from each other). These biases have similarly prevented the use of these sources in most previous JP research. We marked each of the 'waves' that had such an Arabic source discussion with a '+' in the supplementary table below.

To determine the certainty that the reported outbreak was referring to plague, we devised a three-level scale. In our analysis, represented in Fig. 1 and in the table below, 'A' level refers to texts that discuss plague symptoms in any detail. In summary, this meant whether they mentioned the buboes often associated with plague along with any additional symptoms. A certainty level of 'B' refers to texts that note a single symptom that can be associated with plague (e.g. buboes). The 'C' certainty level refers to texts that use general terminology to discuss a mortality, disease or epidemic, but that provide no evidence that the outbreak was necessarily plague and not some other disease.

For each text in our final analysis, we calculated the number of words employed to report a plague (or another epidemic) across texts. We erred on the inclusive side, even when this entailed including sections that are not necessarily about plague, but discussed a disease outbreak and, in the past, had been linked to plague outbreaks. In a few cases with higher word counts (listed below) or when we had no easy way to tally the number of words used, we averaged the words per line or per page. Thus, the numbers listed in the table are, at times, approximations, but within an acceptable margin of error. For the single text in Geʿez (a language from East Africa, 15 words) we used the English translation instead of the original language.

Using the supplementary tables below, we counted the median word count for each plague description.

To calculate the number of Greek authors we used the *Thesaurus Linguae Graecae* (*2*), a near-comprehensive dataset of Greek sources before 1453 CE. Our reported number of authors is based on their 'Authors by century' chart after excluding "Long Ranges" and "Varia and Incerta". To calculate the number of Latin authors, we consulted a comprehensive dataset of all written Latin sources from this period in the *Clavis Patrum Latinorum* (*3*) and counted only authors who wrote during the sixth century. We included law codes, monastic rules, and

penitentials in the calculation that could be dated to the sixth century, the first and allegedly most demographically ruinous century of the Justinianic Plague. We excluded all dubious, spurious, pseudo, and anonymous materials, which would have increased the total number of sources and correspondingly lowered the percentage of plague mentions. Finally, we excluded all 35 saints' lives that *Clavis Patrum Latinorum* dated to the sixth century, since there was a significant chance of overlap in authorship between the lives and other written sources.

In the following table, the first three columns show the temporal, spatial, and textual aggregation of the results, suggesting many catastrophic outbreaks. The last two columns tally the total word count in the plague descriptions of that wave, and the median word count different plague sources have for the same wave. We chose median as our measure of central tendency to avoid the high outliers distorting our results.

Supplementary Table 1 – A summary of JP 'waves' in the historical texts (data underlying Fig. 1). 'Waves' follow Stathakopoulos' division. Note: the information in the last three columns is sometimes duplicated between 'waves' (Data: *1*).

Wave	Dates	Occurrence area	Number of historical texts that refer to plague	Total word count in plague descriptions	Median word count in plague descriptions
1	541-544	Egypt, Asia Minor, Palestine, Syria, Italy, Sicily, North Africa, Illyricum (modern Croatia), Algeria	15	9704	115
2	558-561	Constantinople, southern Asia Minor	4	2832	183.5
3	571-574	Italy, France, Constantinople, "the East"(?)	7	497	25
4	590-592	Cities in northern/central Italy, Antioch (modern Antakya)	5	2120	290
5	597-601	Greece, Turkey, Syria, Italy, North Africa	7	2754	24
6	618-619	Constantinople, Alexandria	5	819	74
7	626-628	Palestine, Persia	1+	11	11
8	639	Syria, Palestine, Iraq	2+	17	8.5

9	669-673	Egypt, Israel, Kufa (in Iraq)	2+	11	5.5
10	680	Rome and Pavia (northern/central Italy)	2	218	109
11	687-690	Syria, Egypt, Basra (Iraq)	1+	800	800
12	698-700	Iraq, Syria, Mesopotamia, Constantinople	3	56	20
13	704-706	Syria, Iraq, Basra, Kufa, Wasit (Iraq)	2+	44	22
14	713-715	Syria, Egypt	4	72	13
15	718-719	Iraq, Syria	secondary works	n/a	n/a
16	724-726	Egypt, Syria, Mesopotamia	6+	208	11
17	732-735	Syria, Egypt, Palestine, Iraq	2	16	8
18	743-750 (or 768)	Egypt, North Africa, Mesopotamia, Syria, Italy, Sicily, Greece, Iraq, Constantinople, Armenia	11	3801	160

The following table provides additional details. Here ‘wave’ refers to the outbreaks proposed by Stathakopoulos (*1*). ID refers to the entry in his catalog. References are the documents Stathakopoulos lists in each entry. ‘Symptom details’ refers to the level of detail in which the source describes plague (A: Description of detailed plague symptoms [reference to buboes and additional info]; B: Description of minimal plague symptoms [reference to buboes or equivalent only]; C: Description with no symptoms [generic disease/mortality]). The level of detail was ranked separately by two authors (L.M. and M.E.), who then compared their ratings and discussed any differences. In cases where the same text appears multiple times within the same ‘wave’, we chose to include only the highest rating.

Supplementary Table 2– The Sources of Plague (details of previous table).

Wave	ID	Reference	Symptom details	Word count	Comments
1	102	Procopius Wars 2.22	A	2110 (*counted in #111*)	

1	103	John of Ephesus, Frag. E (229) = Pseudo-Dionysius of Tel Mahre 77	A	*total counted in #111*	
1	103	epigraphic material from Gaza, Nessana, Rehovot, Eboda	n/a	n/a	inscriptions
1	104	Procopius Wars 2.22	A	2110 (*counted in #111*)	
1	104	John of Ephesus, Frag. E (229) = Pseudo-Dionysius of Tel Mahre 77, 80	A	*total counted in #111*	
1	104	Chronicle of Seert I, 32 in PO 7, 185	A	490	Correct reference is II.32, pp. 182-86
1	104	Michael the Syrian II 235-8	A	1600	Counts for Michael the Syrian must be impressionistic since he exists only in unedited manuscript form. We used an average of 500 words/page, and included the theological explanation for plague that is an important part of the chapter.
1	105	Cyril of Scythopolis, Vita of Kyriakos 10 (229)	C	40	
1	106	J. Koder, Ein inschriftlicher Beleg zur justinianischen Pest in Zora; *Byzantinoslavica* 56 (1995) 13-18.	n/a	n/a	inscription
1	107	Vita of Symeon Stylites the Younger 69 (I 59-60)	A	165	
1	108	Evagrius 4.29	A	598	
1	109	Zacharias Rhetor, Fragment Ch. IX (II 129-130)	A	112	
1	109	Leontios of Neapolis, Vita of Symeon Salos, 151	C	115	
1	110	Vita of Nikolas of Sion (ed. Anrich), 52 (40-41)	A	123	
1	111	Procopius Wars 2.22-23	A	2110	Main count for Procopius
1	111	John of Ephesus (frags. F-G) = Ps. Dion. Tel Mahre, 74-93	A	4140	Total count for John of Ephesus, estimated count based on multiplying the average number of words on the page.
1	111	Malalas 482	C	83	
1	111	Theophanes 6034	C	13	
1	112	Vita of Theodore of Sykeon 8 (I 7-8)	B	89	

1	114	Victor of Tunnuna, Chronica, ed. Mommsen (*MGH AA* 11=Chronica Minora saec. IV-VII/2) ad a. 542 (201)	B	15	
1	115	Manganaro, Byzantina Siciliae, *Minima Epigraphica et Papyrologica* 4 (2001), p. 133	n/a	n/a	inscription
1	116	Marcellinus Comes ad a. 543 (107)	C	11	
1	117	N. Duval, Nouvelles recherches d'archeologie et d'epigraphie chretienne a Sufetula (Byzacene), *Melanges d'archeologie de l'ecole francaise de Rome* 68 (1956)	n/a	n/a	inscription
1	118	I.B. de Rossi et al. eds., *Inscriptiones Christianae Urbis Romae septimo seculo antiquores*, Nova Series (=ICUR NS), 10 volumes; Rome 1922-1992.	n/a	n/a	inscription
2	134	Agathias 5.10	A	322	
2	134	Malalas 489	B	32	
2	134	Theophanes 6050	B	31	
2	136	Theophanes 6053	C	14	
2	136	Vita of Symeon Stylites the Younger 126-129	C	2433	
2	136	The Seventh Century in the West Syrian Chronicles 15	n/a	n/a	Based on this reference, Palmer 15 is the Edessene Apocalyptic Fragment, which probably should not have been included, since it does not explicitly mention plague.
3	144	Marius of Avenches 571 (238)	B	25	
3	144	Gregory of Tours, History of the Franks, 4.31 in MGH version	A	334	
3	145	John of Biclair 572-3 (213-14)	B	26	
3	145	Chronicon ad 846, 174	B	10	
3	145	Agapios 437	C	12	
3	145	Michael the Syrian II 309-310	B	75	
3	145	John of Nikiu XCIV 18	C	15	Ge'ez, we used word count from an English translation

4	151	Liber Pontificalis 65 (I 309)	n/a	n/a	The reference says nothing about plague or the cause of death for Pelagius, which is suggested as plague elsewhere.
4	151	Gregory of Tours, History of the Franks 10.1	B	43	
4	151	Gregory the Great, Dialogues 3.19.1-2	n/a	n/a	This reference mentions a flood, but not the plague.
4	151	Gregory the Great, Dialogues 4.18.2	C	164	
4	151	Gregory the Great, Dialogues 4.27.6	C	552	
4	151	Gregory the Great, Dialogues 4.37.7	C	368	
4	151	Gregory the Great, Dialogues 4.40.3	n/a	n/a	
4	151	Paul the Deacon, Hist. Lang. 3.23-34 (127-128)	B	213	
4	154	Gregory the Great, Register Epis. Vol 1, 2.2 (90-91)	C	105	
	154	Paul the Deacon, Hist. Lang. 4.4 (145-6)	B	77	
4	155	Evagrius 4.29 (178, 11-16)	A	598	
5	156	Miracles of St. Demetrios 29-46 (I 57-82)	A	2426	Estimated length
5	159	Theophylact Simocatta 7.15.2	A	51	
5	160	Michael the Syrian 2.373-374	B	24	
5	160	Chronicon ad 1234, 171	C	12	Included but uncertain plague identification
5	161	Elias of Nisibis 911 AG (60)	B	16	Used Arabic version
5	162	Gregory the Great, Register epis. 9.232 (814-5)	C	171	Included but uncertain plague identification
	162	Gregory the Great, Register epis. 10.20 (850-1)	C	32	Included but uncertain plague identification
5	163	Paul the Deacon, Hist. Lang. 4.14 (150-51)	C	14	
5	164	Paul the Deacon, Hist. Lang. 4.14 (150-51); copied by Agnellus 101 (386)	C	8	
6	173	Nikephoros, Short History 8, 12 (48, 54)	C	27	
6	173	George the Monk, Chronicle 669	C	28	
6	173	Miracles of St. Artemios, 34 (52)	A	540	

6	175	Leontios, Life of John the Almsgiver 24 (375)	C	74	
7	175	Anonymous, Life of John of Almsgiver, 37 (53)	C	150	Estimated length
7	177	Michael the Syrian 2.412	B	11	
7	178	Secondary sources: von Kremer, Seuchen 107; Dols, Plague, 376; Conrad, Plague 159-163; Conrad, Plague Chronologies, 62, 68, 79; Treadgold, History, 298-9	n/a	secondary	See discussion above about problems with Arabic sources
8	180	Elias of Nisibis AH 18 (64)	C	8	Used Arabic version
8	180	Michael the Syrian II.431	B	9	
8	180	"Arabic sources": Conrad, Plague, 167-246.	n/a	secondary	See discussion above about problems with Arabic sources
9	185	Secondary sources: von Kremer, Seuchen, 108; Conrad, Plague, 250-3; Conrad, Plague Chronologies, 62, 82	n/a	secondary	See discussion above about problems with Arabic sources
9	186	Theophanes 6164	C	5	
9	186	Agapios 492	C	6	
10	192	Liber Pontificalis 81.16 (I 350)	C	62	
10	192	Paul the Deacon, Hist. Lang. 6.5 (213-214)	C	156	
11	194	John bar Penkaye, in Brock, North Mesopotamia in the late Seventh Century, 15.160-165 (68-71)	C	800	Estimated based on average words per page
11	194	Theophanes 6179	n/a	n/a	No plague mentioned here (only famine)
11	194	Elias of Nisibis AH 68 (72)	n/a	n/a	No plague mentioned here (only famine)
11	194	Michael the Syrian II.474-5 - famine and plague	n/a	n/a	No plague mentioned here (only famine)
11	195	Secondary sources: von Kremer, Seuchen, 108-9; Conrad, Plague, 260-9; Conrad, Plague Chronologies, 55, 62, 66-7, 69-70, 82-3; Dols, Plague 379	n/a	secondary	See discussion above about problems with Arabic sources
11	196	no primary; Conrad, Plague, 271-3	n/a	secondary	See discussion above about problems with Arabic sources
12	198	Elias of Nisibis AH 79 (74)	C	12	Used Arabic version
12	199	Theophanes 6190	B	14	
12	199	Nikephoros, Short History 41 (98)	C	16	

12	200	Theophanes 6192	C	6	
12	200	Elias of Nisibis 80 AH (74)	B	8	Used Arabic version
13	201	Chronicle of Zuqnin, 1016 AG (148)	C	28	
13	201	Michael the Syrian II 480	C	16	
13	203	Secondary sources: von Kremer, Seuchen, 109; Conrad, Plague, 277-8; Conrad, Plague Chronologies, 55-6, 62, 68-9, 83-4; Dols, Plague 379	n/a	secondary	See discussion above about problems with Arabic sources
14	205	Chronicle of Disasters (AD 716 in Seventh Century in West Syrian sources) AG 1024 (45-46)	C	41	This text has not, to our knowledge, been edited, since it is a fragmentary insertion in a larger text. The English translation by Brock amounts to 41 words, but we did not have access to the fragmentary original manuscript.
14	205	Chronicon ad 819, 1024 AG	C	6	
14	205	Michael the Syrian II.482	B	5	
14	207	Severos, History of the Patriarchs, 17 (67-68)	C	20	
15	209	no primary sources; secondary are von Kremer, Seuchen, 113; Conrad, Plague, 286-8; Conrad, Plague Chronologies, 56, 85; Dols, Plague 380; Conrad, Historcal Evidence and the Archaeology of Early Islam, p. 270#4-6	n/a	secondary	See discussion above about problems with Arabic sources
16	212	no primary sources; Conrad, plague, 289	n/a	secondary	See discussion above about problems with Arabic sources
16	213	Theophanes, 6218	C	5	
16	213	Vita of Willibald, Bishop of Eichstatt 4 (100)	C	157	
16	213	Agapios 506	B	10	
16	213	Elias of Nisibis AH 107 (78)	B	12	Used Arabic Version
16	213	Chronicon ad 819, 1036 AG	B	10	
16	213	Michael the Syrian II.491	C	14	
17	214	Theophanes, 6225	C	10	
17	214	Agapios 507	C	6	Plague reference is in 508
18	218	Severos, History of the Patriarchs, 18.97, 115	C	47	

18	219	Chronicle of Zuqnin 1055-6 (168-174)	A	1000	A dubious entry that is an epidemic/famine account but not necessarily bubonic plague (included); estimated length
18	219	Michael the Syrian II.506, 508	C	20	
18	219	Chronicon ad 1234, 248-249	C	160	
18	220	Theophanes, 6238	A	320	
18	220	Byzantine short chronicle 1, 17	C	108	
18	220	Letter of Pope Zacharias to St. Boniface In PL 89 Epistola X. Zachariae papae ad bonifacium archiepiscopum	C	21	Included but uncertain plague identification
18	221	Theophanes, 6238	A	320 (*counted in #220*)	
18	221	Byzantine short chronicle 1, 17	C	108 (*counted in #220*)	
18	221	Byzantine short chronicle 2, 4	B	10	
18	221	Nikephoros, Short History 67 (138-140)	A	325	
18	221	Nikephoros, Antirhetikos III 496B-497A	B	980	Estimate based on 49 sentences
18	221	Theodore Studites, Laudatio Platonis PG 99, 805B-D	C	490	Estimate based on 24.5 sentences
18	222	Chronicle of Zuqnin, 1061-2 (184-9)	A	105	

Fig. 2
The Novels (Roman laws) that serve as the basis of this analysis were dated by Blume (*4*), Noailles (*5*) and Miller and Sarris (*6*). We harmonized the minor discrepancies between the three datasets. Following any of their respective dates would not change the results of our analysis.

Notably, only two laws (Novels 118 and 122) have been connected with the plague. Novel 118 made changes to inheritance laws and does not discuss the plague as a cause, but instead was the culmination of a long trend in inheritance law and was one of many novels about property rights (*7*: 96; *8*: 75). Novel 122 was issued in 544 and attempted to curtail increased labor prices and, therefore, has been linked to the first plague outbreak (*6*: 799). Yet, this law was not issued during the most devastating first year of the outbreak in Constantinople and, moreover, the language ("the chastening that has been sent by God's goodness") is vague and could refer to any type of natural disaster (e.g. earthquakes) or military catastrophe (*6*: 799; *9*: 67-8). Three laws related to burial practices (Novels 43, 59, and 60) date to several years before the plague outbreak and, therefore, burial practices do not seem to have legally changed after the plague.

Fig. 3
This dataset was compiled from the papyri.info website (*10*). We searched for specific years (i.e. 520 to 521 for 521), with 'strict' on (see website for their terminology). We also searched this dataset for words that might suggest the outbreak of the plague but found none. A potential exception is noted in Papaconstantinou (*11*), who comments that the key word is fragmentary and has been reconstructed, while the context suggests other possible explanations than plague deaths.

Fig. 4
This dataset used the dating proposed by Banaji (*12*) and Mazza (*13*). Banaji included exact years; in a few cases, Mazza's dating included intervals, and we only used the documents that were dated within an interval of 3 years or less. Removing either dataset, or using only documents that date to a specific date, would not change our results.

Fig. 5
We scraped this dataset from the digital version of the IGLS (https://inscriptions.packhum.org/, *14*). All the inscriptions from this dataset are in Greek and come from Greater Syria – modern Syria, Lebanon, Jordan, Israel, and Saudi Arabia). We included only those inscriptions dated to a specific year (i.e. annual resolution).

Fig. 6
We constructed this dataset from a series of searches in the Epigraphic Database Heidelberg (https://edh-www.adw.uni-heidelberg.de/home, *15*), which aggregates Latin inscriptions. We searched for each decade, then verified the search results manually to include only those inscriptions with an annual resolution.

Fig. 7
We constructed this dataset from searching the Epigraphik-Datenbank Clauss / Slaby (http://db.edcs.eu/epigr/epi.php?s_sprache=en, *16*) database. We searched for 500-599, then included only those inscriptions with an annual resolution.

Fig. 8
This dataset was built from searching the Epigraphic Database Bari (http://www.edb.uniba.it/about, *17*). We downloaded the results, then filtered them with a script to include only those with an annual resolution.

Fig. 9
This dataset was built from scraping individual entries in the Hispanica Epigraphica database (http://eda-bea.es/, *18*) for their dating information, which we then aggregated in a table. We considered only inscriptions with an annual resolution.

Note for Figs. 6-9
All these collections focus on Latin inscriptions but are not always clear about their methodology and the sources they gathered their entries from (generally smaller in-print collections). Some of

the results in these datasets therefore overlap to an extent. However, this does not impact our conclusion since we consider each dataset separately and find no plague effect in any of them.

Figs. 10-11
The pollen percentages were taken from the dataset published in Izdebski, Koloch, and Słoczyński (*19*). We separated the seven lines into two scales on both y-axes to increase the figures' readability. A single scale would not change the resulting analysis. The mid-sixth century was not a major watershed in any of the regions surveyed, despite claims for massive depopulation in the countryside, similar to the role the Black Death played in certain European regions several centuries later. The locations from which pollen was analyzed appear in Fig. S4 below. Regional pollen from the specific sites in each region appear in Figs. S4a-g below. Please note that following the analysis of Izdebski, Koloch, and Słoczyński (19), the trend lines are based on the spatial and temporal distribution of data points from all sites from 500 BCE-2000 CE).

Brief analyses of regional land use trends in the period of Late Antiquity (c. 300-800 CE)
South Greece: significant increase in cereal pollen and parallel slight decline in pine pollen reflecting the expansion of cultivation and rural settlement under the Eastern Roman Empire (as a response to globalized trade in the Mediterranean and demand for food supplies from the newly-founded city of Constantinople). The expansion trend slows down after 600 CE and reverses into decline in cereals after 700 CE.

West Bulgaria: significant increase in cereal pollen in the period c. 300-500 CE. These are high-elevation sites and the results can be interpreted as intensive colonization of more marginal areas during the times of increasing insecurity in the Balkans and, at the same time, an initial phase in the development of a specialized pastoral economy that achieved its most complex state in late medieval and early modern times.

Northwest Turkey: decline in both cereal and pine pollen c. 300-500 CE, afterwards a contrary development: increase in cereal and pine ca 500-700 CE. Taking into account the other regional pollen curves presented in the original publication, we interpret this as initial deforestation related to the foundation and urban growth of the new nearby mega-city of Constantinople, followed by expansion of cereal cultivation in the later part of Late Antiquity (visible also in other parts of Anatolia) and woodland regrowth in higher elevation areas.

North central Turkey: increase in cereal pollen c. 200-450 CE (which should be interpreted as expansion of cereal cultivation, related probably to the overall demographic and economic growth in late Roman Anatolia). A subsequent decline c. 500-650 CE (major) and 650-800 CE (minimal), accompanied by a steady increase in pine pollen appears to signal major agricultural decline in this part of Anatolia due to warfare (with the Sasanians and then the Arabs) that was taking place in Eastern Anatolia and the Caucasus.

North Greece: increase in cereal pollen c. 300-450 CE, decline c. 450-800 CE. The increase in pine pollen c. 300-500 CE (potentially coming from higher-elevation areas, disturbed by invasions) should be interpreted together with the developments taking place in W Bulgaria. Seems to suggest increasing cultivation in the most central and secure parts of the Balkans,

which is then interrupted by the increasing disruption of the late Roman order in the Balkans in the course of the 5th and 6th c. CE.

East Bulgaria: these are lowland sites near the Black Sea and are therefore strongly connected to the main military/naval and trading networks of the Eastern Roman Empire. We observe a steady increase in cereal pollen c. 300-700 CE, accompanied by a decline in pine pollen – which reflects the growing importance of these areas for the feeding of the Roman army in the Danube area and for supplying grain to Constantinople. This trend ends in the late 7th/early 8th c., after the Bulgars invaded this part of the Balkans.

Southwest Turkey: decline in cereal cultivation c. 400-700 CE, accompanied by a growth in pine pollen. These are high-elevation yet still agricultural sites in the relatively isolated mountainous areas of Pisidia and Lycia. Local communities went through a period of urban renewal in the earlier centuries of Late Antiquity, but apparently this area experienced decreasing focus on cereal cultivation and forest regrowth (secondary ecological succession) in the later part of Late Antiquity, already in the 5th century, similar to north central Turkey (which are also inland sites). This may be partly related to decreasing population numbers, but potentially also to specialization in pastoralism, visible for instance in the area of Sagalassos in southwest Turkey (in the pollen data – not shown here – and in the archaeological record).

Fig. 12
We aggregated the data published in Kay (*20-21*) to reach the results on the right side of the figure and in the left column on the left side of the figure. The data for 'all plague cemeteries' aggregates the data for all the cemeteries listed in Keller et al. (*22*) in which evidence of *Y. pestis* was found, with the earlier finds in Aschheim and Altenerding. Table S2 and Fig. S6 list and map the sites considered in the analysis of the British burial evidence.

Supplementary Text to aDNA section

Late Antique Y. pestis DNA, Mass Graves and Documented JP Outbreaks

Three factors largely account for the failure to isolate *Y. pestis* DNA from mass graves and areas where JP large plague outbreaks are documented. First, the approach historically has been access-driven: proximity to and availability of material remains, reasonably well-dated and catalogued, not historical narratives, explains the choice to interrogate material from Aschheim and Alternerding (*23-26*), from which *Y. pestis* was first reliably isolated using late antique remains, as it does for 16 of 22 sites considered in Keller et al. (*22*), which are also in Germany, like the labs where nearly all work on JP-era *Y. pestis* has taken place.

Second, most attempts to isolate pre-laboratory *Y. pestis* DNA have been unsuccessful (as *22, 27* stress), despite non-random sampling and a selection bias towards inhumations thought more likely to be plague positive. Nonetheless, we must consider the current positive detection rate an underestimate of the real extent of the pathogen's circulation. False negatives remain a reality for multiple reasons: i) taphonomic limitation of DNA preservation of both host and pathogen DNA in widely differing contexts, ii) substantial septicemic 'load' of *Y. pestis* DNA is required in the pulp cavity of teeth at time of death, and iii) shifting technique sensitivities.

Third, as stressed in the paper, not all mass graves are plague pits. *Y. pestis* did not occur in a vacuum: other epidemics, perhaps pandemics, as well as subsistence crises, affected late antique populations (*1, 28-30*). Significantly, the remnants of some diseases that could have spread widely at the time (notably RNA viruses) are difficult to detect today (*31*).

Fig. S1. The bronze folles per gold solidus ratio per year.
This is a visualization of the raw data from Banaji (12), following Sarris' use of the same dataset to argue for a plague effect (32).

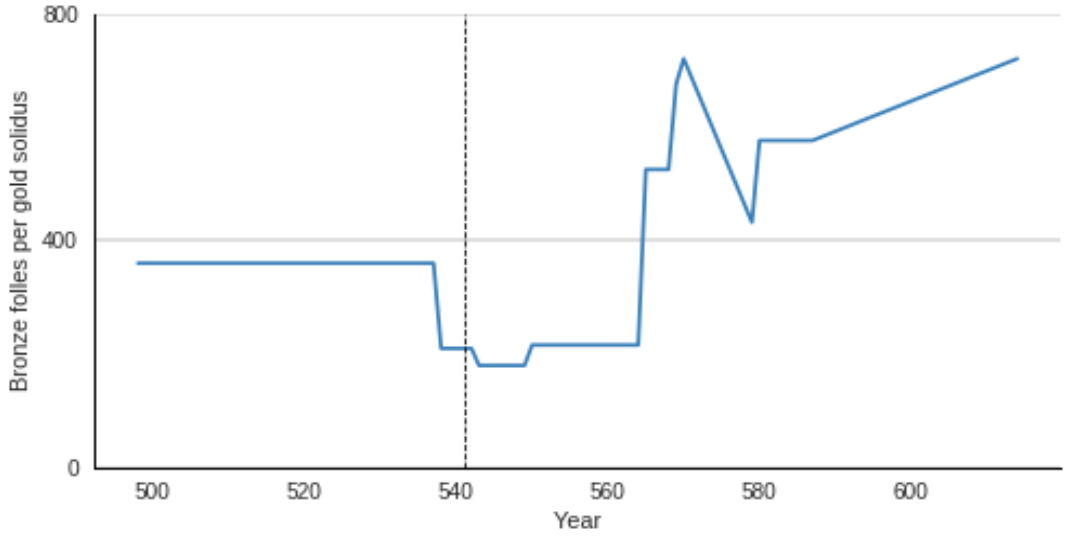


Fig. S2. Coins found in Antioch (annual resolution). Analysis begins in 538 CE since that was the date of an imperial monetary reform that changed the size and quantity of coins the state produced (*33*).

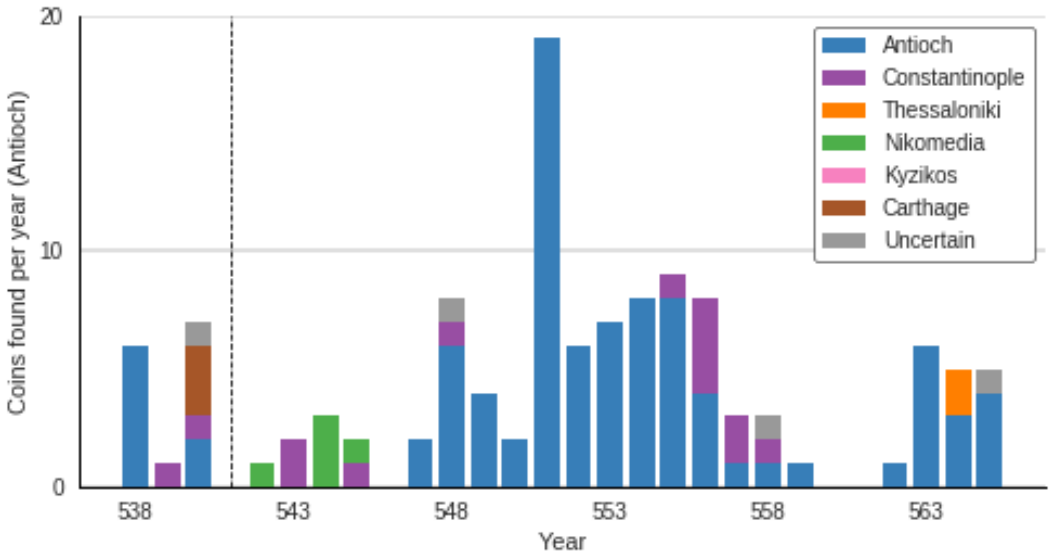


Fig. S3. Coins found in Beirut, annual resolution (*34*).

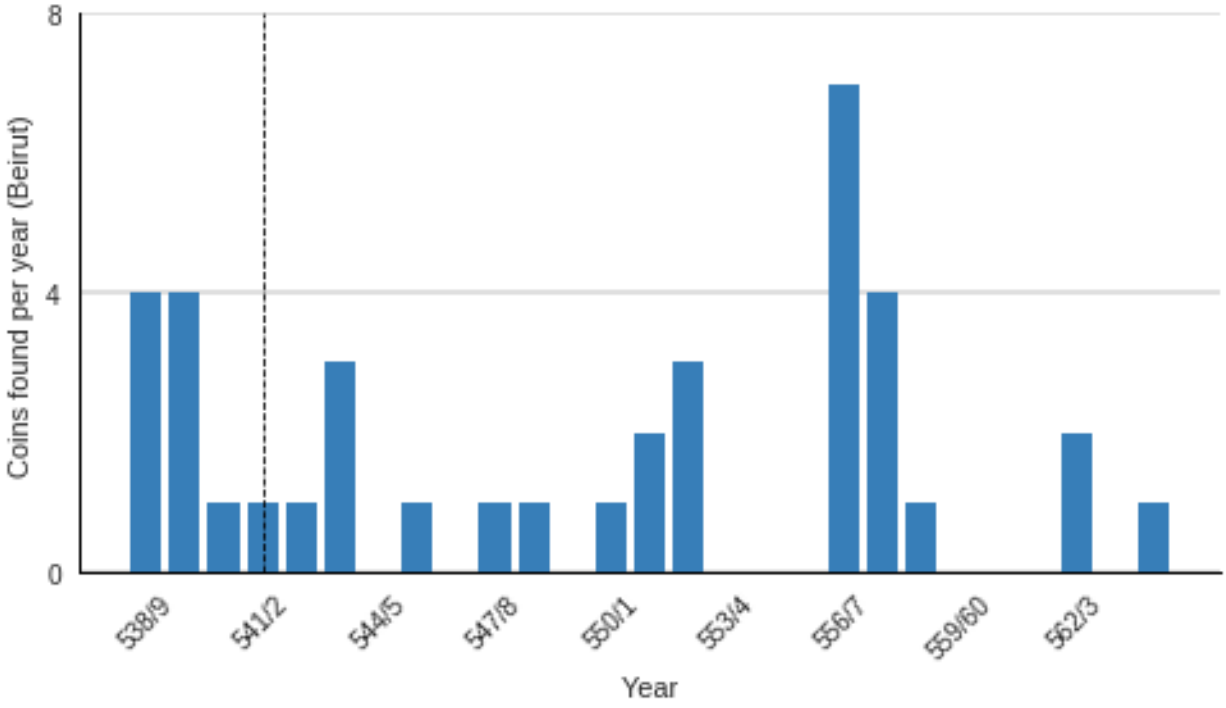
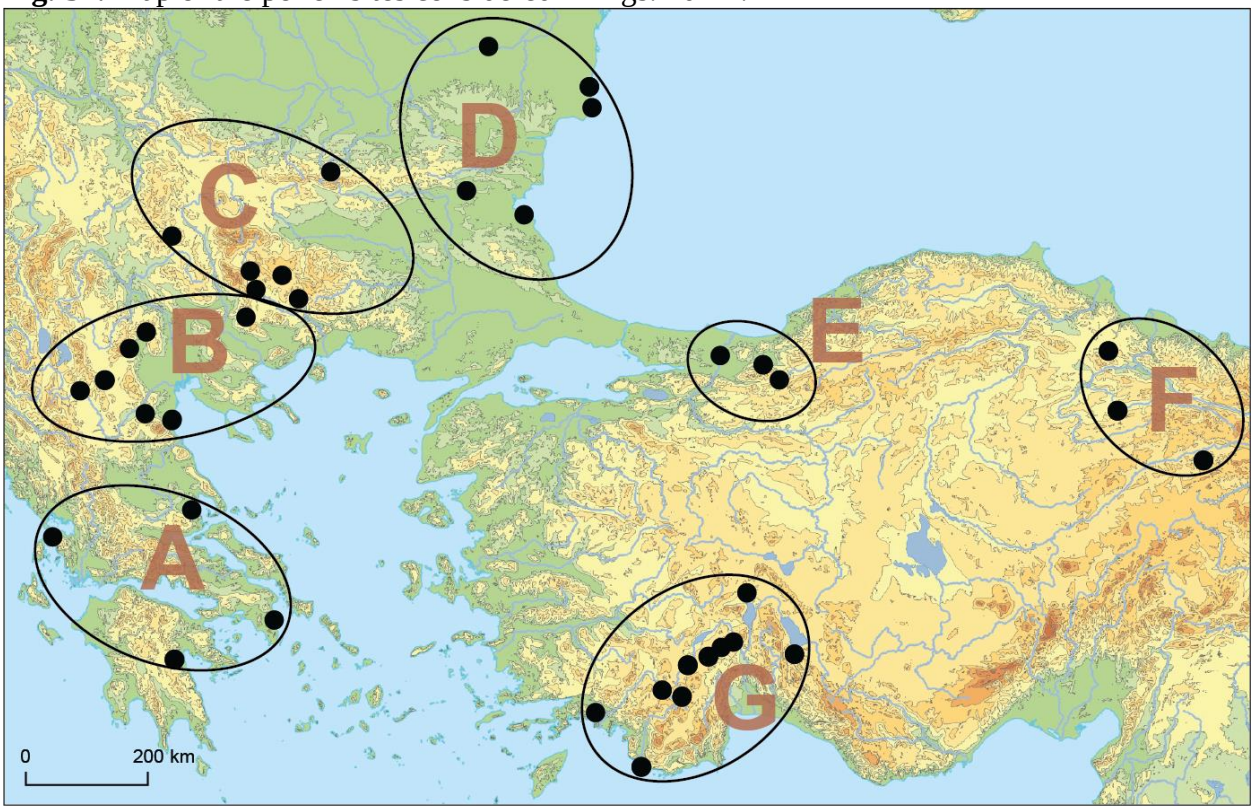


Fig. S4. Map of the pollen sites considered in Figs. 10-11.



● pollen sites

A S Greece B N Greece D E Bulgaria F North central Turkey
C W Bulgaria E NW Turkey G SW Turkey

Fig. S4a. Pinus and cerealia pollen in sites in southern Greece.

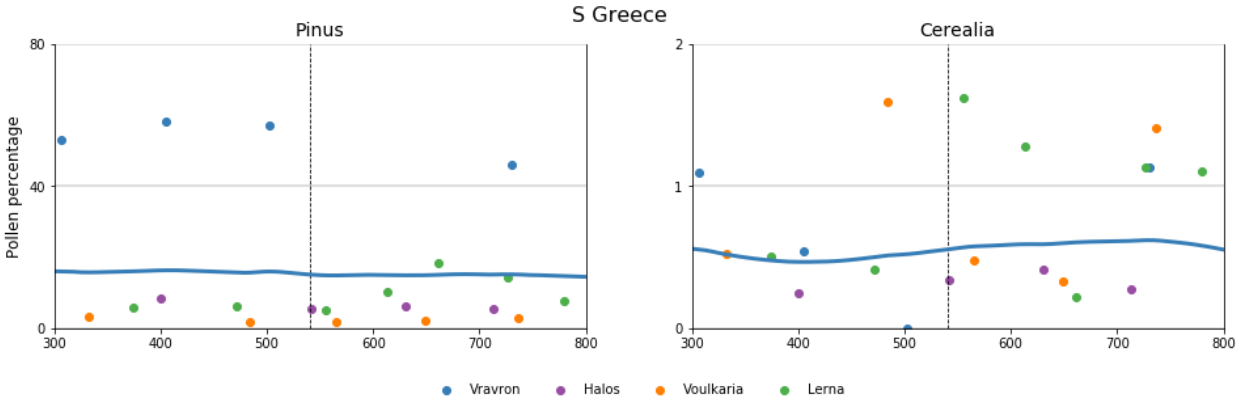


Fig. S4b. Pinus and cerealia pollen in sites in northern Greece.

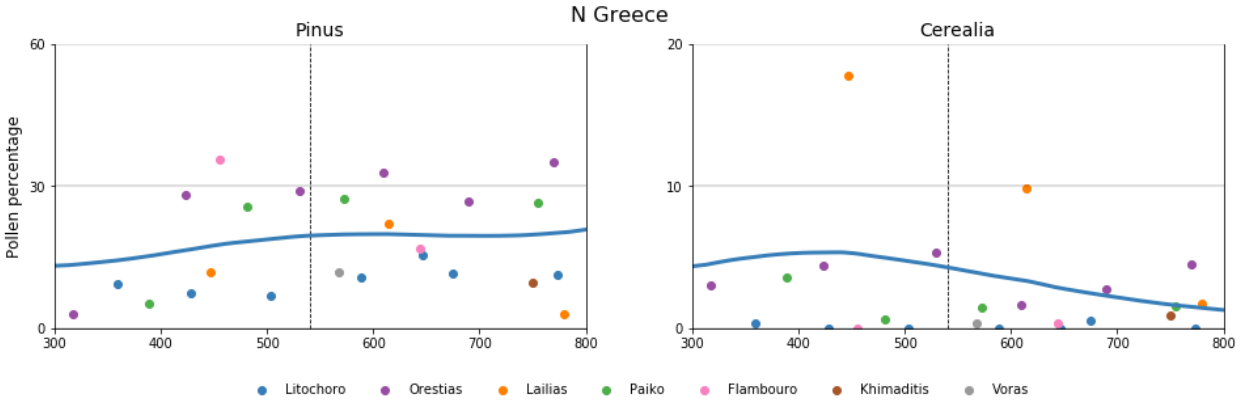


Fig. S4c. Pinus and cerealia pollen in sites in west Bulgaria.

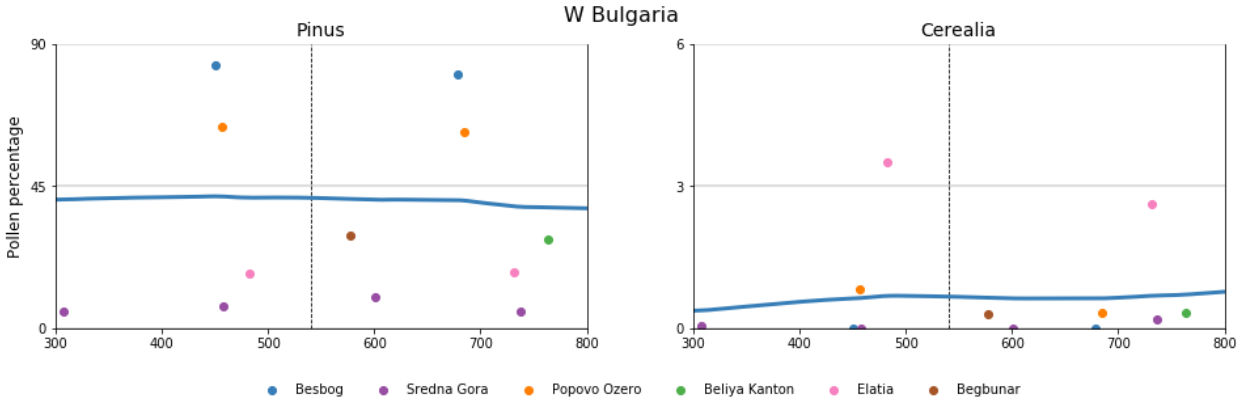


Fig. S4d. Pinus and cerealia pollen in sites in east Bulgaria.

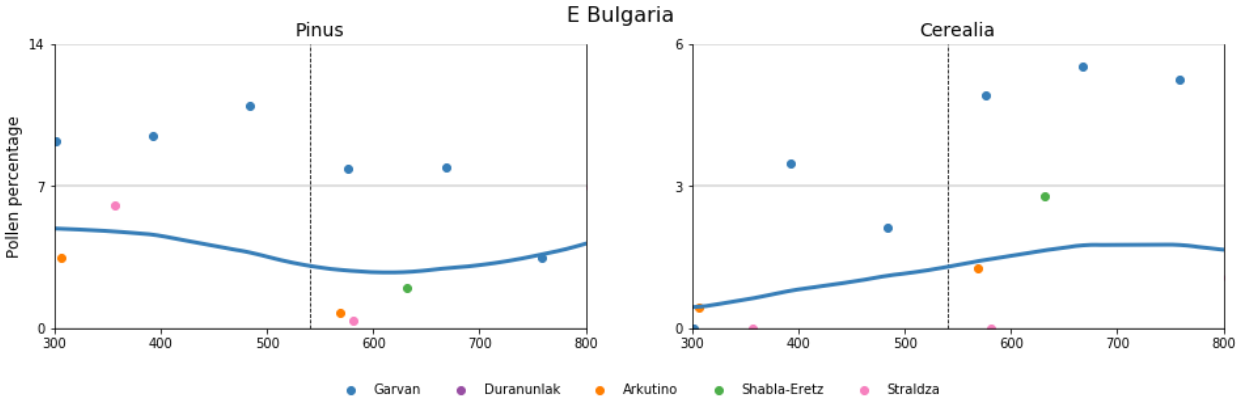


Fig. S4e. Pinus and cerealia pollen in sites in northwestern Turkey.

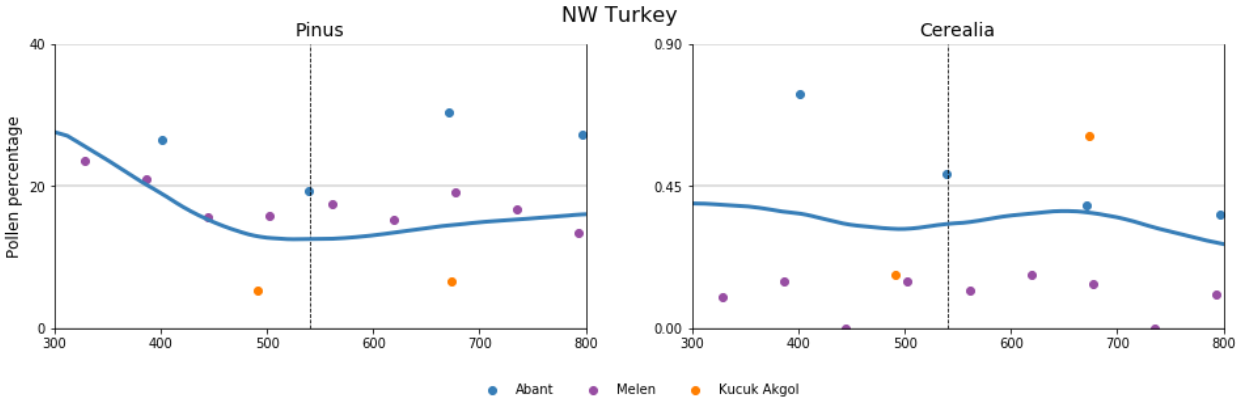


Fig. S4f. Pinus and cerealia pollen in sites in north central Turkey.

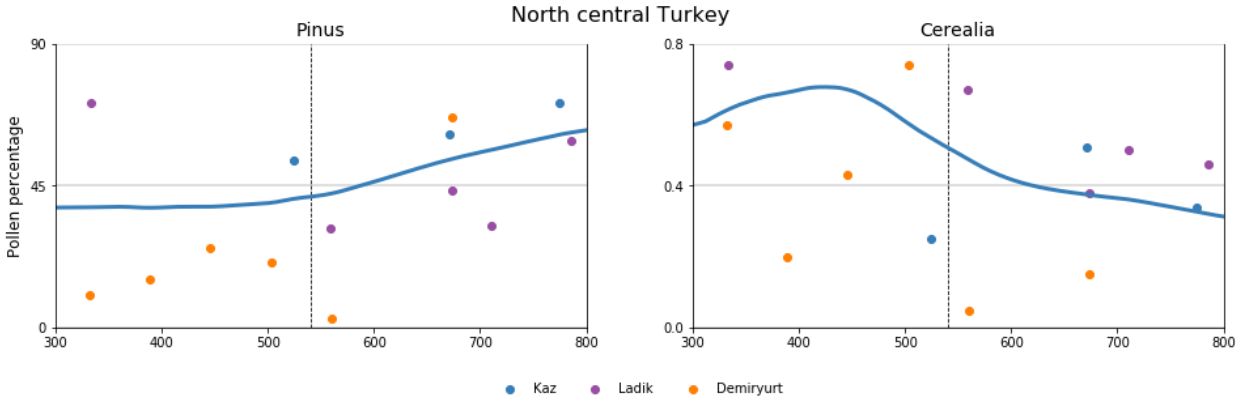


Fig. S4g. Pinus and cerealia pollen in sites in southwestern Turkey.

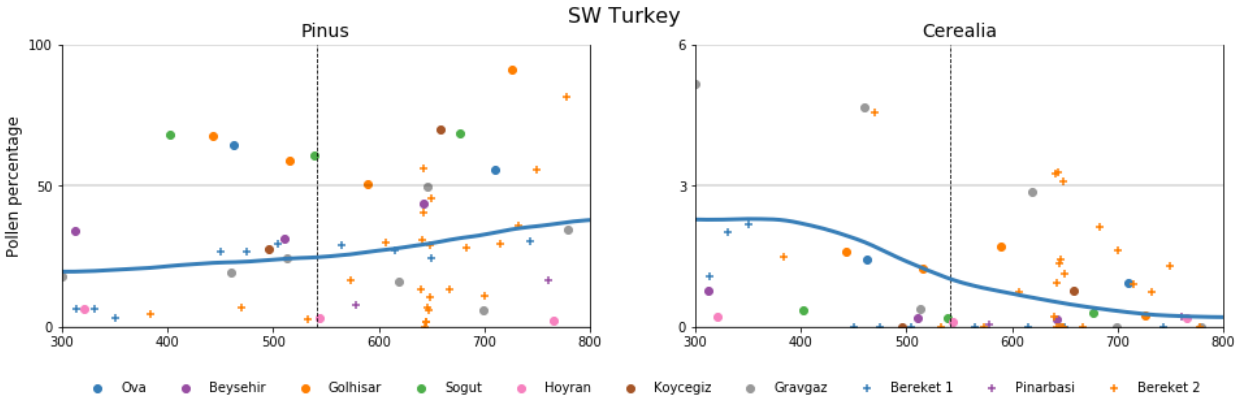


Fig. S5. Reconstructed population of the Aschheim settlement based on local burials (*35*).

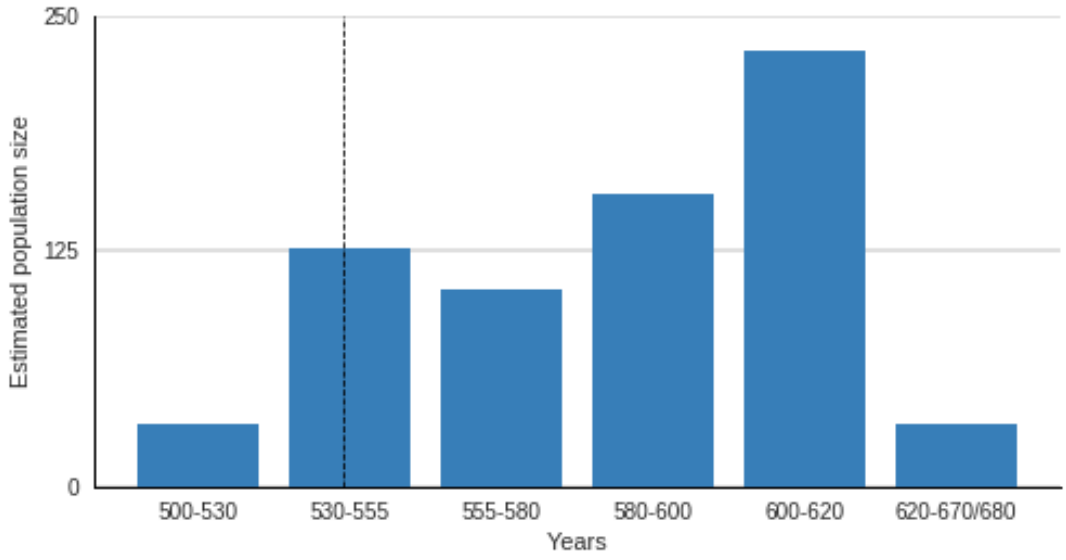


Fig. S6. Maps of the British sites considered in this study, organized by periodization.

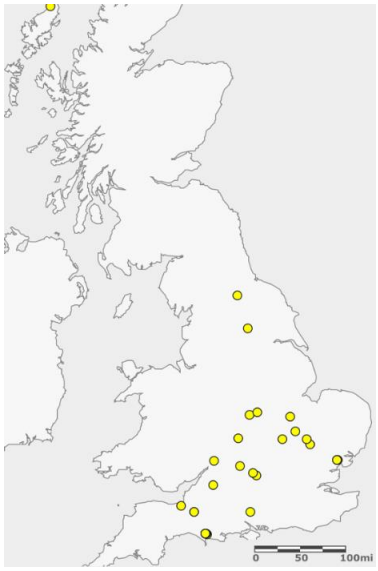
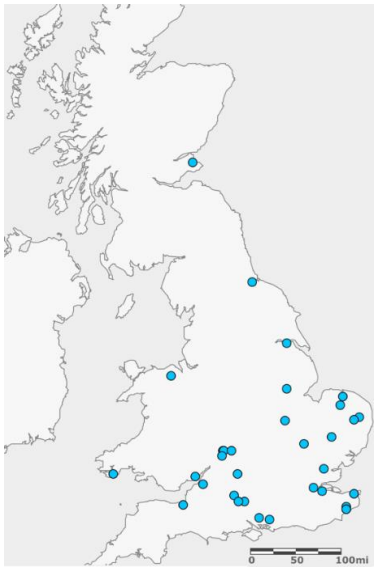
Period 1 – late- and early-post-Roman (c.270-425)	Period 2 – used at least c. 400-500	Period 3 – used c.450 and after
		

Table S1. Published isolations of *Y. pestis* DNA for the Justinianic Plague. See comments on the problems with the 2004, 2005 and 2007 'PCR' studies in the paper.

Study	**Location of Sites Tested**	**Burial Information**	**Material Tested**	**Number of *Y. pestis* - Positive Individuals**
Drancourt et al 2004 (*36*)	Sens, **France**	Four 'mass graves' C^{14}-dated to 5^{th}-6^{th} centuries	Unclear: 10 teeth from 3 individuals or 19 teeth from 8 individuals	Unclear; *Y. pestis* detected in 'one mass grave'
Wiechmann, Grupe 2005 (*26*)	Aschheim, **Germany**	Cemetery with 438 individuals (see below); both individuals in one double inhumation tested	2 teeth from individual 166, 4 teeth from individual 167	1 (individual 167)
Drancourt et al 2007 (*37*)	Vienne, **France**	12-individual 'mass grave' C^{14}- (and numismatically) dated to 7^{th}-9^{th} centuries	18 teeth from 5 skeletons	2
Harbeck et al 2013 (*24*)	Aschheim, **Germany**	Cemetery with 438 individuals (see above); 4 of 8 *pla*-positive individuals dated archeologically to 530-70, 1 other to 590-630, remaining 3 C^{14}-dated to 431-544, 443-566, 435-631	2 'or more' teeth from 19 individuals from 12 'multiple burials'	*pla* gene /*Y. pestis* detected in 8 individuals; individual A120 found *Y. pestis*-positive in 3 analyses preformed
Wagner et al 2014 (*25*)	Aschheim, **Germany**	Cemetery with 438 individuals (see above); 2 individuals tested C^{14}-dated to 443-566 (A76) and 435-631 (A120)	4 teeth from individual A120, 1 from A76	2 (individuals A120, A76), 1 genome
Feldman et al 2016 (*23*)	Altenerding, Aschheim, **Germany**	Altenerding cemetery with ~1,450 individuals (see above), Aschheim with 438 (see above); Altenerding individuals AE1175 and E1176 archeologically dated to 530-70 and C^{14}-dated to 426-571; Aschheim individual A120 C^{14}-dated to 435-631	Unspecified number of teeth from 20 individuals from double burials; including 2 teeth each from 2 individuals (AE1175 and AE1176) from a single inhumation; also re-tested individual A120 from Harbeck et al 2013 (*24*) and Wagner et al 2014 (*25*)	2 from Altenerding (AE1175 and AE1176), 1 from Aschheim (A120), 1 genome

Keller et al 2019 (*22*)	Leobersdorf, **Austria**; Edix Hill, **Britain**; Alladorf, Dirlewang, Dittenheim, Forchheim, Grafendobrach, Kleinlangheim, Leobersdorf, München-Aubing, Neuburg an der Donau, Peigen, Petting, Regensburg Fritz-Fend-Str., Sindelsdorf, Straubing Aziburg I/II, Unterthürheim, Waging, Westheim, **Germany**; Lunel-Viel Les Horts, Lunel-Viel Quartier Centrale, Saint-Doulchard, **France**; Valencia, **Spain**	8 sites were *Y. pestis*-positive: Dittenheim cemetery, archeologically dated to 550-700, with 238 graves and 10 cremations, including 4 double inhumations; Edix Hill cemetery, archeologically dated to 500-650, with 115 graves, including 9 double and 1 4-person inhumations; Lunel-Viel Quartier Centrale grave site, archeologically dated to 400-600, including 6 double inhumations in two trenches; Petting cemetery, archeologically dated to 530-730, with 721 graves, including 2 double and possibly 2 triple inhumations; Saint-Doulchard burial trench in early/high medieval cemetery with 175 graves, 48 distinct singular graves in trench, radiocarbon dated to 650-880; Unterthürheim cemetery, archeologically dated to 525-680, 256 graves , including 14 double, 2 triple and 1 4-person inhumations; Valencia cemetery, archeologically dated to 500-700, with 67 graves, including 3 double, 3 triple, 4 4-person, 2 5-person and 15 >5-person inhumations; Waging cemetery, archeological dated to 500-700, with 67 graves, including 2 double and possibly 1 triple inhumation	171 teeth from "a minimum of" 122 individuals from 21 continental sites; 22 additional sequence samples from Edix Hill, Britain	34 *pla* gene / *Y. pestis*-positive samples of 191 teeth sampled; 2 classified as outliers/*Y. pestis* negative. *Y. pestis*-positive samples, including genomic analysis, Dittenheim (3, including 1 genome), Petting (3, including 1 genome), Unterthürheim (5, including 2 genomes) and Waging (1, including 1 genome), Germany; Valencia (1, including 1 genome), Spain; Lunel-Viel Quartier Centrale (6, including 3 genomes), Saint-Doulchard (11, including 2 genomes), France; Edix Hill (4, including 3 genomes), Britain

Table S2. A list of the British sites considered in the analysis and their periodization.

Period 1 – late- and early-post-Roman (c.270-425)	**Period 2 – used at least c. 400-500**	**Period 3 – used c.450 and after**
Alington Ave, Dorchester	40 Queen St, Herts.	Apple Down, West Sussex
Asthall, Oxon.	Alton, Hamps.	Beckford A, Worcs.
Babraham Hall, Cambs.	Auchterforfar, Angus	Beckford B, Worcs.
Barton Court *Infant Cemetery*, Oxon.	Baldock, California, Herts.	Bergh Apton, Norfolk
Bletsoe, Bedfords.	Barton Court (Buildings), Oxon.	Bishop's Cleeve, Gloucs.
Bradley Hill *Building 3*, Som.	Berinsfield, Oxon.	Blacknall Field, Wilts.
Bradley Hill *North Cemetery*, Som.	Bradley Hill *Southern Cemetery*, Som.	Broadway Hill, Worcs.
Cannington (Pd.1), Som.	Buckland, Dover, Kent	Butler's Field, Gloucs.
Catterick Bridge, N. Yorks.	Caerwent (Vicarage Orchard), Mon.	Caerwent (Pipeline), Mon.
Maldon Road, Colchester, Essex	Cannington (Pd. 2), Som.	Cannington (Pd. 3). Som.
St Johns, Colchester, Essex	Catstane, Midlothian	Castledyke South, Sheffield
Butt Road (Site Ph. 1), Colchester, Essex	Catt. (Bainesse SSD 1), N. Yorks.	Cuxton, Kent
Butt Road (Site Ph. 2), Colchester, Essex	Catt. (Bainesse SSD 10), N. Yorks.	Darenth Park, Kent
Galson, Lewis	Collingbourne Ducis, Wilts.	Droxford, Hamps.
Jesus Lane, Cambridge	Four Winds, Midlothian	Edix Hill, Barrington A, Cambs.
Lankhills, Hamps.	Great Chesterford, Essex	Glapthorn Rd, Northants.
Little Keep, Dorchester	Henley Wood, Som.	Gunthorpe, Cambs.
Lynch Farm, Cambs.	Lundin Links, Fife	Hallow Hill, Fife
Nettleton, Wilts.	Mill Hill, Kent	HP, Filton, S. Gloucs.
Newarke St, Leicester	Minerva, Cambs.	Lyminge, Kent
Old Vicarage, Ford., Dorchester	Mucking (AS I), Essex	Monkton, Kent
Poundbury *Main*, Dorchester	Mucking (AS II), Essex	Morning Thorpe, Norfolk
Poundbury *East*, Dorchester	Oakington, Cambs.	Norton, N. Yorks.
Poundbury *North*, Dorchester	Orpington, Kent	Porthclew, Pembs.
Poundbury *Site C*, Dorchester	Park Lane, Croydon, Kent	Portway, Andover, Hamps.
Poundbury *Outlying*, Dorchester	Plas Gogerddan, Cardiganshire	Quarrington, Lincolns.
Queenford Farm, Oxon.	Salt. Tunnel *East*, Kent	Saltwood Tunnel *Central (West)*, Kent
Radley Barrows, Oxon.	Stretton-on-Fosse, Warks.	Saltwood Tunnel *West*, Kent
Tubney Wood (Pd. 1), Oxon.	Temple Hill, Dartford, Kent	Spong Hill, Norfolk
Wasperton (Pd. 1), Warks.	Thornybank, Midlothian	Springfield Lyons, Essex
Watersmeet, Hunts.	Tittleshall, Norfolk	Tandderwen, North Wales
Wattle Syke, N. Yorks.	Tolpuddle Ball, Dorset	Watchfield, Oxon.
Wotton Cemetery, Gloucester	Tubney Wood (Pd. 2), Oxon.	Westgarth Gardens, Suffolk

Wasperton (Pd. 2), Warks.

West Heslerton, N. Yorks.

West Overton, Wilts.

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