Revolt and Resistance in the Ancient Classical World and the Near East

In the Crucible of Empire

Edited by

John J. Collins and J.G. Manning

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CHAPTER 10

Revolts under the Ptolemies: A Paleoclimatological Perspective

Francis Ludlow and J.G. Manning

> *The river,* [*since it will not have*] *sufficient water,* [*will flood*]*, but* (*only*) *a little so that scorched will be* [*the land . . .*] *but unnaturally.* [*For*] *in the* [*time*] *of the Typhonians* [*people will say*] *'wretched Egypt,* [*you have been maltreated*] *by the* [*terrible*] *malefactors who have committed evil against you.' And the sun will darken as it will not be willing to observe the evils in Egypt. The earth will not respond to seeds. . . .*
>
> *The Oracle of the Potter*
>
> TRANS. BURSTEIN (1985:136–139)

Valuable insights and a comparative framework have been offered by scholars such as Brian McGing to further our understanding of some of the most important events in Ptolemaic history, namely the intermittent revolts and other forms of social unrest that punctuated the history of Ptolemaic Egypt, 305–30 BCE.[1] There is much we know about this unrest, beginning with a basic chronology from literary and documentary sources. Often, however, we lack certainty of the exact timing and spatial evolution of these events. For we are dealing not only with singular self-contained events, but with consecutive and sometimes overlapping series of social disturbances of varying intensities and durations, some long-lasting, others short-lived, with different geographic extents, documented in varying degrees of fidelity throughout the centuries of Ptolemaic rule.

Our goal in this chapter is to outline the main explanations offered to date for the causes of unrest in the Ptolemaic period, before proceeding to contribute a new perspective that implicates volcanically-induced shocks to the agriculturally-critical summer Nile flood as potential triggers in many revolts.

1 A large literature now exists on the Ptolemaic revolts. The standard reference is Veïsse (2004). See also the treatments by Pestman (1995); McGing (1997); Hölbl (2001:153–59) and Fischer-Bovet (2015). A brief summary of events is provided by Clarysse (2004).

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To date, while the causes of unrest have been debated, they are understood by most scholars as springing from nationalism, economic problems or some combination of these and other factors. Ethnic tension there surely was, and it is well documented. Such tension was likely exacerbated by the new fiscal system that organized tax collection according to ethnic/occupation groups, and one money tax, the salt tax, privileged "Hellenes" as a separate class.[2] But whether national feeling among a majority of Egyptians had evolved toward an abstract conception of "Egypt" is an idea that must be engaged with critically, and so too the role of ethnic tensions as a trigger, as opposed to an exacerbating factor, for revolt and other forms of local, regional or statewide unrest.

The largely accepted historical arc of the rise and decline of the Ptolemaic state is based on the Greek historian Polybius. That framework posits that during the reign of the first three Ptolemaic kings, 305–222 BCE, Egypt was generally stable, and politically and economically successful. Beginning with the reign of Ptolemy IV in 221 BCE, the dynasty began to decline, effectively becoming a Roman protectorate after Antiochus IV's second invasion in 168 BCE. Egypt was formally made a Roman province after the defeat of Antony and Cleopatra at Actium in 31 BCE.[3] The cause of Ptolemaic decline has often been discussed, and it is generally thought that state power waned because of a combination of internal problems (ethnic and potentially nationalistic tension between Greeks and Egyptians; over-extraction of resources leading to rebellion, currency inflation), the depravity of the kings themselves, and the increasing political and military domination of the Mediterranean by Rome. Polybius adds political neglect, moral decay, and Ptolemy IV's love of opulence and a succession of kings (some of them quite young) after him who were in the grip of nefarious courtiers.[4] Added to this combination of stressors, it has been suggested by several scholars that a sense of Egyptian nationalism that rose up at opportune moments to attempt to throw off Ptolemaic oppression was also a driver of internal unrest (Green, 1991:364; McGing, 1997).

1 Narrative Sequence of Social Unrest

The first sign of documented unrest in Ptolemaic Egypt comes at the beginning of the Third Syrian War fought against the Seleukids (Veïsse, 2004; Grainger, 2010:163–64). According to Justin, *Epit*. 27.1.9, a "domestic sedition" required

2 Clarysse and Thompson (2006).

3 Polybius 5.34 describes the political decline of the Ptolemies beginning with Ptolemy IV. For a good historical overview, see Hölbl (2001, esp. p. 127ff.).

4 More nuanced remarks in Monson (2007). On Polybius' moralizing, see Préaux (1965).

Ptolemy III to return to Egypt in 245 BCE from initial military success in Mesopotamia.[5] A further text refers to it as an "Egyptian revolt" (P. Haun. 6; McGing, 1997:274). The exact nature of this event is unclear, despite being much discussed. It has been suggested that the documentary record is insufficient to suggest any widespread social unrest in the 240's BCE (McGing, 1997:277), while other scholars cite 245 BCE as the date of a revolt (Monson, 2007). Whatever the nature or the extent of the trouble, it is noteworthy that in a famous trilingual inscription (known commonly as the Canopus Decree, dated to 4 March 238 BCE), Ptolemy III is portrayed as having saved Egypt during a severe famine, at great expense by importing grain:

> *. . . . and* (*since*) *when on one occasion the rise of the river* (*i.e. the Nile*) *was insufficient and all the inhabitants of the country were terrified at what had happened and remembered the disaster that occurred under some of the previous kings, under whom it happened that all the people living in the land suffered from a drought, they showed their care for the residents in the temples and the other inhabitants of the country, and showed much foresight and sacrificed a large part of their revenues for the salvation of the population, and by importing corn into the country from Syria, Phoenicia and Cyprus and many other places at great expense, they saved the inhabitants of Egypt. . . .*[6]

The king was by implication able to import sufficient grain to maintain political stability, demonstrating among other things the benefits of controlling external territories in the third century BCE in which agricultural fortunes were effectively independent of the mercurial Nile. The text describes what was surely a major event, and therefore worthy of mention in the decree, particularly for a mainly Nile-dependent economy structured on the commercial export of grain to other parts of the Mediterranean. But this impending famine, in whatever year(s) it may have occurred (the Canopus decree does not specify, but erratic Nile flooding and failure, possibly over several years, may

5 There are various interpretations of what exactly the events were behind this "sedition". McGing (1997:274–77), concludes on the basis of the surviving documentary record that there is no evidence for an "explosion" in the countryside, and that events around the year 245 BC "amount to very little." On the events, see Hauben (1990).

6 The Greek version of the decree (*OGIS* 56), lines 13–19. Trans. Austin (2006:471). For a full treatment of the text, see Pfeiffer (2004). On the locations of the "many other places," see Buraselis (2013:101).

be presumed to have occurred between 245 and the date of the decree),[7] must have been severe indeed given the likely costs of the importation into and distribution of grain through the Egyptian countryside. The crisis may have been exacerbated by fiscal demands on rural production to fund the Third Syrian War (below). As a side-note, it is worth noting that subsistence stresses are probably underreported in our sources generally, given the nature of the survival of papyri that tend to be found either in official or private archival contexts, and often concern the fiscal interests of the state or private agreements. We would not expect such kinds of documents to mention social conditions on a frequent basis.

Two key texts, *P. Tebt.* 703 and *P. Hib*. II 198, concerning administrative responses to emergency can perhaps be dated to the 240's BCE, and are important in giving us a sense of political and economic difficulties in Egypt between 245 and 240 BCE and the efforts by the state to manage them. In *P. Hib*. II 198, runaway sailors (also mentioned in *P. Tebt*. 703) are called "those who have been branded with the (royal) mark" (probably slaves) and were to be treated as "brigands".[8] The system of assigning soldiers plots of land in exchange for service, the kleruchic system, was "in very great disorder between 246 and about 240 BC" (Turner, 1984:158). *P. Tebt*. 703, a major administrative document, records efforts to re-establish bureaucratic control of the country. Special attention was paid to supplying Alexandria with grain:

> *Take care that the grain in the nomes, with the exception of that expended on the spot for seed and of that which cannot be transported by water, be brought down. It will thus be easy to load the grain on the first ships presenting themselves; and devote yourself to such business in no cursory fashion. Take care also that the prescribed supplies of grain, of which I send you a list, are brought down to Alexandria punctually, not only correct in amount but also tested and fit for use* (*P. Tebt*. 703, 80–85).

The king, in both reality and theological terms, sat at the nexus between ecological crisis and political response. Private petitions were addressed to him. One such petition written in Greek, probably a draft, reinforces the severity of Nile failure in this period. The text, requesting a royal audience, was written

7 Bonneau (1971:126–30) suggested on the basis of her assembly of Nile flood quality assessments from Greek papyri that severe Nile failure occurred in 245 BC. Between 244 and 238, Bonneau indicates normal (244 BC) to abnormally high Nile flooding (241, 240 BC) (itself potentially damaging), with no data for 243, 242, 239 and 238 BC.

8 See the remarks by Turner and Lenger (1955:98–99).

most probably by a soldier (given his name and title) living in Edfu, a major temple town in Upper Egypt. It is not dated specifically, but it is generally thought by paleography to be a third century BCE text (and fitting the presumed circumstances ca. 245 to 238 BCE) (Turner, 1984:31–32; Lukaszewicz, 1999:29). It mentions a Nile failure of three years' duration, and claims knowledge of a new irrigation "machine" that could "save" Egypt from famine:

> *To King Ptolemy, Greetings, from Philotas, the fire-signaller, one of the Kleruchs in Apollinopolis-the-Great. Given that now and for a long time, the inundation has become insufficient, I want, O King, to inform you of a certain machine the use of which does no damage and by means of which the country may be saved. Since during the last 3 years the river has not flooded, the dryness will produce a famine that* [. . .] *but if you wish, this will be a year of good flood. I ask you, O King, if it seems good to you, to order Ariston the strategos, to grant me 30 days sustenance, and to send for me as quickly as possible to you or* [. . .] *a petition so that, if it pleases you, seed will grow immediately. Thanks to your decision, within 50 days there will immediately follow a plentiful harvest throughout the whole Thebaid. Farewell.* (P. Edfu 8; Lukaszewicz, 1999).

We do not know specifically what the petitioner had discovered. The introduction of the water-lifting device known as the *saqiya* is, however, generally dated to around this time, ca. 240 BCE, on the basis of its mention in Philo of Byzantium's *Pneumatics*. Michael Lewis has suggested that between 260–230 BC many new water lifting machines, rotary machines, were invented in Alexandria (Lewis, 1997:20–21). Whether the *saqiya* itself was "invented" in Alexandria in response to a specific crisis at this time is unclear (Wilson, 2008:351–52, Oleson, 2000); perhaps our petitioner had improved upon it. A large gift of grain to Egypt from Hieron II of Syracuse can, perhaps, also be placed in these years, "during a shortage of grain in Egypt".[9]

The "Decree of Alexandria" dated December 243 BCE, the first full copy of a trilingual priestly decree known from the period, celebrated initial Ptolemaic success during the Third Syrian War, without mention of any social unrest (El-Masry et al., 2012, esp. pp. 176–78). In that same year Ptolemy III took the

9 *FGrH* III B, p. 606; Athen. V.206e–209c. All that is certain is that the gift occurred during Hieron II's reign 269–214 BCE, but the 240's BCE fits the circumstances neatly. Huß (2001:368) cautiously remarks that the gift of grain to Ptolemy III is not certain. Zambon (2008:220) is more certain in following Athenaeus, and suggests that the gift of the large ship (the *Syrakosia*) to Ptolemy III had not only grain but "sun-dried fish, fresh tuna and cheese."

epithet "benefactor" (*Euergetes*) (Hölbl, 2001:49). The fact that there is no mention of unrest in the decree is not necessarily surprising; the text celebrates the initial military success in the Near East and royal piety toward Egyptian cults. But we know that Ptolemy III returned from his campaign in 245 BCE because of internal troubles. It seems likely that this decree (and others), were motivated by political crises, and in detailing such events as military success, a royal birthday, and royal piety, were intended to presented a picture of state strength and normality, with endorsement by the priesthood.

The years in which we know that priests met in synods, and issued decrees, or at least years in which synodal meetings are mentioned, are: 266/5, 264/3 (that these first two documents were synodal decrees is rightfully doubted by J. Quack), 243, 238, between 221 and 217, 217, between 199 and 196, 196, 186, 185/4, 182, 161 and 112 BCE (the last is also doubtful).[10] While not all decrees can be expected to be borne of crisis, it is striking that many of these dates correspond to war and/or social unrest (Huß, 1991). D. J. Crawford is worth quoting in detail here:

> *The interpretation of this series of priestly synods from the late third and early second centuries BC is not easy. For the reign of Epiphanes* (*scil. Ptolemy V*) *the cumulative nature of the evidence is striking and coincides with change and Egyptianisation in other spheres. This is the period when the aulic titulature is overhauled and standardised, when the Egyptian dating system of demotic scribes supersedes all others and receives official recognition. These priestly decrees occur against a backdrop of serious trouble in Egypt, with parts of the country escaping from central control. When victory is celebrated in the decrees, Horus has conquered his enemies and the Ptolemy becomes the victorious pharaoh supported by the traditional gods of Egypt. But the victories are real and the records preserve interesting details such as the capture of Lycopolis recorded in the Rosetta decree, the success of Aristonicus in the south in 185 in the decree from Philae, or in Syria before the decrees of 182 BC. It would probably be naive to understand these decrees as reflecting simple gratitude to the ruler on the part of the priests. The concessions which Epiphanes made were also very real. Large sums were spent on the temples; the privileges made to the priests also affected their land and must have involved the royal treasury in a loss of revenue* (Crawford, 1980:35).

10 See Huß (1991); Hölbl (2001:162–69); Quack (2008). Discussion of the demotic language versions of the Canopus, Raphia and Memphis decrees can be found in Simpson (1996).

The state, and agricultural production, ultimately recovered from the potential troubles of the 240s. In 227/226 BCE, Ptolemy III was able to send a sizeable gift of grain to Rhodes, after a devastating earthquake there, amounting to 30 million liters of grain, "one of the largest shipments known from the ancient world" (Gabrielsen, 2013:68; Polybius 5.88/1–90.4). More trouble lay ahead, however. After the major Battle of Raphia (modern Rafah) in 217 BCE that concluded the Fourth Syrian War, returning Egyptian troops rioted. Polybius described the events:

> *The war against the Egyptians started shortly after the battle at Raphia (in 217 BCE) in which Ptolemy IV by gaining an unexpected victory on the Seleucid Antiochus III managed to keep control over Palestine. By arming the Egyptians for his war against Antiochus, Ptolemy had an excellent idea for the short time, but he did not take into account the future. Priding themselves upon their victory at Raphia, the soldiers were no longer disposed to obey orders, but they sought out a leader and figure-head, in the opinion that they could come up for themselves. And shortly afterwards, they did indeed do so.*[11]

Military mobilization for the battle at Raphia was massive: a total of 70,000 infantry, 5,000 cavalry and 73 war elephants on the Ptolemaic side (Fischer-Bovet, 2014:73). This was a defensive war, to prevent the Seleukid army from reaching Egypt. The Raphia decree, dated November 217 BCE, records the battle and its aftermath. Raphia was a particularly expensive battle, 8,000 Greek mercenaries, 8,000 Libyans were added to the core fighting force, as were 20,000 Egyptian soldiers (Fischer-Bovet, 2014:81). Fischer-Bovet notes, plausibly, that the price of mercenaries may have jumped in these years because of their demand in the western Mediterranean during the Second Punic War. After the success at Raphia, Ptolemy rewarded the army with 300,000 pieces of gold.[12] But by 200 BCE, the loss of external Nile-independent territories, including Coele-Syria, severely depressed Ptolemaic revenues.

Polybius described the years 219 to 217 BCE as a major turning point in the history of the Mediterranean, and an inflection point when the Hellenistic states were increasingly and irreversibly weakened and Rome rose. Ten years later, perhaps the most significant unrest, being one of the longest revolts known in the ancient Mediterranean, generally known as the Theban Revolt,

11 Polybius 5.107.1 and 14.107.1 See also 5.65.1–10; 79–87. Polybius also noted that after these events the king fell into "debauchery".

12 Hölbl (2001:131) with sources.

broke out in the Thebaid (Upper/Southern Egypt) and lasted from ca. 207 to 186 BCE.[13] Much of Upper Egypt from Asyut (Lycopolis) up to Aswan (although the border town of Aswan, with its garrison, appears to have remained loyal) pulled away from Ptolemaic control. Two kings, in succession, of unknown origin, were proclaimed. As far as the evidence permits, no taxes were collected by the state, for twenty years.[14] Serious (potentially related) unrest is also documented in the Delta (Lower/Northern Egypt) from 197 to 185 BCE (McGing, 1997:284). Riots involving a wide social spectrum are recorded in Alexandria in 203 BCE.[15] Whether these are all linked is uncertain, but it is credible to think that they were. Documents suggest that the revolt in Upper Egypt was both violent and widespread. Dramatically, one of the first potentially related acts of the rebels was the seizure and stoppage in the construction of the great temple at Edfu. Temple construction in Thebes was also stopped. General confusion reigned throughout the countryside. Land was abandoned. One text, from Asyut, in part, reads as follows:

> *From the time of the revolt of Chaonnophris it happened that most of the farmers were killed and the land has gone dry. When, therefore, as is customary, the land which did not have owners was registered among the "ownerless land," some of the survivors encroached upon the land bordering their own and got hold of more than was allowed. Their names are unknown since nobody pays taxes for this land to the treasury. But of the cultivated area nothing has been overlooked, because the land-measurement of what is sown has taken place each year, and the taxes are being executed—*[16]

We might infer from such reports that grain prices increased. Unfortunately we do not have very many grain price data for the mid to late third century BCE (Von Reden and Rathbone, 2015). A general rise in prices in the late third century has, however, been observed, and various explanations offered

13 Polybius connects the post-Raphia rioting in 217 BCE with the later Theban revolt but there is little evidence to directly connect the two. For the doubtful connection between these two events, see Fischer-Bovet (2014:91). For the ambiguity in the literature regarding the somewhat unclear onset of this revolt, see footnote 25.

14 The Ptolemies began to issue receipts for certain types of tax payments. There are no known tax receipts from Upper Egypt below Aswan, the key southern border town that may have remained in state control, from these years.

15 Polybius 15.25–33. Barry (1993) argues that the riots were broad-based and included the military, and not simply Egyptians, per Fraser (1972:119–31).

16 *SB* XXIV 15972 (Greek papyrus, Trinity College Dublin, Pap. Gr. 274; dated ca. 190 BC). Trans. Clarysse, (1994). See the comments on the text by McGing (1997:299–310).

(Von Reden, 2007:70–72). One indication of increased prices can be observed in land tenancy agreements from the village of Tholthis dated 218–214 BCE. Therein occurred,

> *unusually high penalty prices for unfulfilled rental payments in wheat and olyra* (*emmer*). *During most of the third century epitima* (*i.e. fines*) *were quite regularly set at 4 drachmas for the artaba of wheat and 2 drachmas for the artaba of olyra. In the Tholthis contracts, by contrast, they amount to 10 drachmas for wheat and 4 drachmas for olyra. . . . penalty prices may not have been very sensitive to actual price fluctuation, but arguably they show prices of olyra to have doubled, while those of wheat had increased by 150 percent* (Von Reden, 2007:70).

One of the historical problems that prevents certainty is that bronze coins were re-tariffed against silver (Reekmans, 1951). T. Reekmans argued that there were some economic problems at the end of third century, but not severe enough to explain a possible grain price increase of 100%. On the other hand, in other periods of re-tariffing, nominal prices of commodities did not rise (Von Reden, 2007:72). Little consideration has been given to date of the potential role of Nile flood shocks (or Nile "failures") behind price increases in Ptolemaic Egypt, nor in the onset of social unrest, something we return to in the following section.

The Ptolemaic state was clearly often resilient enough to recover from famine and revolt. The Theban revolt was finally put down in 186 BCE, and a heavier presence of soldiers and administrative control in the Upper Nile valley was established. But famine, revolt, dynastic troubles, the cost of quasi-continuous war during the third century BCE, and the imposition of a new and extractive fiscal system, continued to put severe pressure on the population, and consequently on the Ptolemaic regime as well.[17] The presumed loss of revenue in grain caused by the Theban revolt, but with potentially associated difficulties starting 207/206 BCE (Clarysse, 2004) made circumstances even worse. The expansion and intensification of (water sensitive) free-threshing wheat production during the third century BCE, well attested in the harvest tax receipts from Upper Egypt[18] and in land registers from the Fayyum, may have also increased the vulnerability of the rural population to the inherent

17 On the cost of war, see Fischer-Bovet (2014:71–77).

18 Packman (1968:56): "the number of payments in wheat is far greater than that of payments in barley or croton-the proportion is greater than six to one- and this circumstance suggests that wheat was by far the most common grain crop in second century Diospolis."

variability of the Nile flood and any associated subsistence crises. The shift to naked wheat from emmer in the newly reclaimed Fayyum is already well illustrated by a crop report dated to 235 BCE that covers nearly half of the total arable land in the Fayyum, almost 500 km^2. In that report, 74.6% of the arable land is under free-threshing (naked) wheat, while barley occupies 14.5% (*P. Petrie* III 75, Thompson, 1999:129).

The loss of many of its external territories (including those capable of rain-fed agriculture) to rivals, and much internal conflict, also played a part in the decline of the state (Hölbl, 2001:181–221). In 200 BCE, Antiochus III permanently removed Syria-Palestine from Ptolemaic control. Between 170–168 BCE, Antiochus IV invaded Egypt twice, and was expelled only with the aid of Rome in 168 BCE. Shortly thereafter, in 165 BCE, another revolt broke out. What may have begun as court intrigue by a man with a Greek and an Egyptian name, Dionysios Petoserapis, so the story goes, soon spread through the ranks of the military and then the rural population who felt predisposed to revolt in the wake Antiochus IV's invasion.[19] Dynastic disputes leading to civil war between Ptolemy VI, Ptolemy VIII and Cleopatra II exacerbated instability. Egyptian rebels are noted as destroying sanctuaries, including one dedicated to soldiers. Unrest in the Thebaid, a "revolt of the Egyptians", is documented near Edfu (noted in the Hor archive, and by Diodorus Siculus (31.17)). Farmers once again abandoned land.

A royal edict entitled "On Agriculture" dating to August/September 165 BCE attempted to solve widespread economic distress.[20] This decree, written in both Greek and Demotic Egyptian, noted that land was devastated, and there was poor Nile flooding. "Forced" leases of land were made at lower prices, and the state required that those who had livestock had to make them available to assist in harvesting (Hölbl, 2001:182, McGing, 1997:294). An increase in wheat prices is noted in the 160's BCE (*UPZ* I 59, 16, Veïsse, 2004:147). Civil war between Ptolemy VI and VIII intensified in the 130's BCE. An Egyptian, Harsiese, attempted a coup in 131/130 BCE (McGing, 1997:295–96). Massive problems are recorded in the papyri dating to the last quarter of the second century BCE. Concessions by the state, corruption of officials, extortion, forced labor, the appropriation of land, false arrest and so on are commonly reported in papyri dated to these years (McGing, 1997:296). A wide-ranging amnesty that attempted to re-establish a political equilibrium throughout the country was published in 118 BCE (*P. Tebt*. I 5). But problems continued

19 Diodoros Siculus 31.15; McGing (1997:289–95).

20 SB 16.12821. The enforcement of these rules created more confusion, and clarification of the edict was made in 164 BCE. See *UPZ* I 110.

throughout the first century BCE. The *Oracle of the Potter*, cited as the epitaph to this chapter, is a well-known literary text couched as a prophecy that describes the nightmarish conditions but foretells the coming of a new savior king who will restore prosperity. It is traditionally dated to the end of the second century BCE. We believe that the entire text can be read as a response, in religious terms, to the linked political, socioeconomic, climatic and environmental conditions that obtained during the second century BCE, and indeed much of its description is reminiscent of the atmospheric, climatic and hydrological impacts of a major volcanic eruption.[21]

1.1 *The Nile and Volcanic Climate Forcing*

Between 1783 and 1784, the great Icelandic fissure volcano, Laki, erupted with widespread environmental and climatic impacts. Over the course of its eight month eruption, the fine ash and tephra particulates, toxic and acidic gases it released (including up to 120 Teragrams of sulphur dioxide injected into the upper troposphere and lower stratosphere (Schmidt et al., 2012)), resulted in damage to vegetation, elevated levels of mortality in Iceland (Stone, 2004) and also widely in and beyond Europe (Courtillot, 2005; Witham and Oppenheimer, 2005). The eruption coincided with a severely cold winter 1783/1784 in Europe (Oman et al., 2006a; Schmidt et al., 2012), and has also been credited with particularly devastating impacts on Egypt, as summarized by Alan Mikhail (2011:218):

> *. . . in the Summer of 1784, there was another major outbreak of plague in southern Egypt. And in the fall of that year, a low Nile flood led to great scarcity and dearth . . . throughout the Egyptian countryside, as fields could not be cultivated. Thus, by the following spring of 1785, much agricultural land throughout Egypt was in a wasteful state and many peasants had died from hunger and plague. This lack of food led to increases in the prices of grains and other foodstuffs and soon plague and "fevers" began to spread throughout all of Egypt.*[22]

An earlier Icelandic fissure eruption, that of Eldgjá, likely starting c.939 CE, is thought to have triggered similar societal stresses in Egypt (Oman et al., 2006b), in both cases by diminishing the Nile summer flood, and consequently

21 For a description of atmospheric optical phenomena associated with volcanic dust-veils (which include not only volcanic dust, but also sulphate aerosols) in the 40s BCE, see Bicknell (1993).

22 See also Mikhail (2015).

agricultural output. Even in the absence of volcanic climatic perturbation, a major feature of the Nile flood is its pronounced inter-annual variability. This is driven by year-on-year variations in summer rainfall associated with the East African Monsoon in the Ethiopian highlands (primarily drained by the Blue Nile and Atbara rivers) which supplies approximately 85% of the summer floodwater (Melesse et al., 2011). This variability has been remarked upon since ancient times, with insufficient floodwater ("Nile failure") often coinciding with harvest failure, famine, mortality and political instability in Egyptian history (Butzer, 1984; Hassan, 2007). Superimposed upon this variability is the impact of volcanism. While the Nile may be particularly sensitive to high-latitude explosive eruptions,[23] climate modelling (e.g., Iles and Hegerl, 2014) and observational studies (e.g., Iles and Hegerl, 2015) also suggest its sensitivity to tropical eruptions.

The widespread and often severe summer cooling (and more variable winter cooling) that can follow large eruptions is now well known, and arises primarily from the backscattering of incoming solar radiation by volcanic sulfate aerosols in the stratosphere (Robock, 2000; Cole-Dai, 2010). While variability in precipitation (and consequently river-flow) is arguably more important for human agriculture in most regions, the impacts of eruptions on precipitation have only recently begun to receive comparable attention to temperature (e.g., Peng et al., 2010; Man and Zhuo, 2014; Man et al., 2014; Shi et al., 2014; Zhuo et al., 2014). Eruptions may impact precipitation in several ways, most directly by reducing evaporation over waterbodies by cooling surface temperatures, thus suppressing mean precipitation on scales ranging from regional to hemispheric and global. High-latitude Northern Hemispheric eruptions (e.g., Icelandic, Alaskan) with aerosol cooling concentrated in higher latitudes also act to reduce the land-sea thermal contrast.[24] Because the summer monsoon

23 More effusive (or mixed effusive/explosive) fissure eruptions with long durations in the high-latitudes of the Northern Hemisphere (such as those of Laki and Eldgjá) seem capable of impacting the Nile (Oman et al., 2006), even though they are often thought less able to inject large amounts of sulphate into the stratosphere in the manner of explosive (e.g., Plinian-style) eruptions, this being a general prerequisite for a large-scale climatic impact.

24 The summer monsoon (upon which many of the most densely populated regions on the Earth depend for precipitation) is triggered when land-surface temperatures rise more quickly from summer-season heating than ocean temperatures (e.g. because, for example, water has a greater thermal inertia than land). The heated air over the land thus rises, creating regions of lower atmospheric pressure than found over the oceans. To equalize this pressure differential, winds blow landward from the oceans, carrying moisture-laden air. This rises upon encountering heated land surfaces (also from orographic uplift, where air is forced rise over physical features such as highlands and mountains) and

is driven by this contrast, high-latitude eruptions may suppress the moisture-bearing summer monsoonal winds over Northern Hemispheric landmasses, including the Ethiopian Highlands that supply the Blue Nile and Atbara Rivers, and consequently the agriculturally-critical Nile flood.

Examining the impact of eruptions upon Egyptian society is hampered by the comparatively short observational record of eruptions (with many major events undocumented before c.1800 CE). Ice-core records in which eruptions are identified through anomalously elevated sulphate deposited in annually-layered polar ice provide the best prospect of accurately extending the known history of major volcanic eruptions, but undiagnosed chronological errors in key Greenland ice-core datasets (amounting to c.7 years by the sixth and seventh centuries CE) have until recently limited their utility (Baillie, 2008, 2010; Baillie and McAneney, 2015; Kostick and Ludlow, 2015). Revisions to ice-core time-scales that now correct these errors allow us to capitalize upon a 2,500-year volcanic reconstruction (Sigl et al., 2015), and for the first time assess the role of eruptions during the Ptolemaic period in well-documented episodes of internal revolt. The period saw numerous explosive eruptions (16 extratropical (i.e., mid- to high-latitude) in the Northern Hemisphere, and eight tropical; Figure 1). Four surpass the estimated global forcing (of -6.5 watts per square meter (w/m^2)) from the 1991 eruption of Pinatubo in the Philippines (Sigl et al., 2015), which represents the largest climatically-effective twentieth century eruption. Four others have estimated forcing of at least -4.0 w/m^2, revealing the Ptolemaic period to be one of considerable volcanic activity, including events surpassing in magnitude any that have occurred in the Modern era (c.1850 onward).

Adapting the list of revolt dates provided by Veïsse (2004),[25] and using the volcanic record and revised ice-core timescale of Sigl et al. (2015), we note

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cools as a consequence, forcing water vapour to condense and precipitate over the land (see Dash (2005) for a brief introduction to monsoon systems). High-latitude Northern Hemispheric eruptions likely impact the summer monsoon by reducing this summer temperature contrast between land surface and ocean surface temperatures.

25 Our list of revolt onset dates is adapted from Veïsse (2004:78–79). In some cases, Veïsse (2004:46) infers unrest by the absence of tax receipts in certain years in Upper Egypt, e.g. after 157–133 BCE. Where alternative revolt onset dates are provided by Veïsse, we use the earlier dates in our testing. We provisionally place the start of the Theban revolt in 206 BCE, following Hölbl (2001:155) who dates the coronation of Horwennefer in Thebes to November 206, thus providing one marker for the start of the Theban revolt. See also Vandorpe (1986). Cessation of the construction of the temple in Edfu in the reign of Ptolemy IV (corresponding to Julian Calendar years 207/206 BCE) is, to err on the side of caution, provisionally counted as marking a distinct instance of internal unrest. Further work is merited to refine the date of internal revolts in Ptolemaic Egypt, and fur-

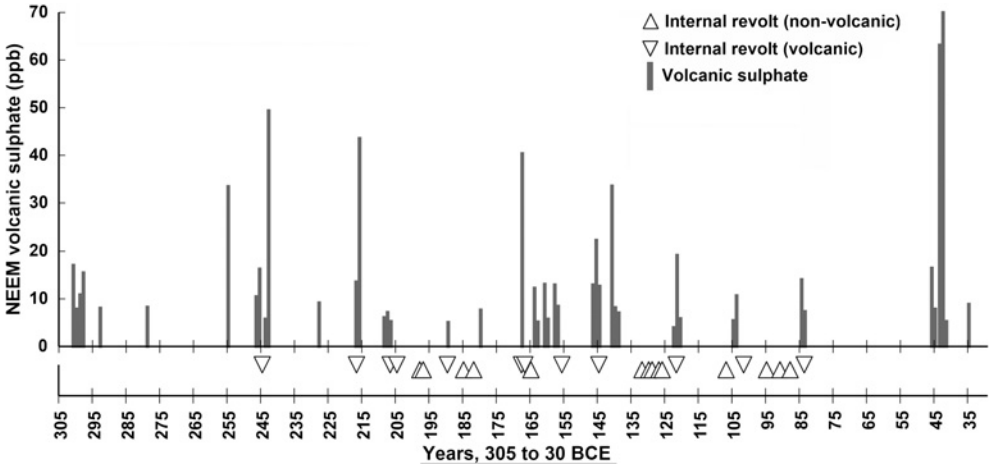

FIGURE 1 *NEEM volcanic sulphate (grey columns) in annual layers of Greenland ice (measured in parts per billion (ppb) (Sigl et al., 2015) with twenty-six internal revolt start years (triangles)). Volcanic sulphate deposition for the 44 BCE eruption amounts to 100.6 ppb, but is truncated above for graphical purposes. Revolts occurring in years of volcanic sulphate deposition or in the two years following have triangles pointing down, while those not associated with volcanic sulphate deposition within this temporal window have upward pointing triangles.*

that 12 of 26 years (i.e., 46.2%) in which internal revolts are known or can be inferred to have begun during the period of Ptolemaic rule, occurred in years with volcanic sulphate deposition, or shortly thereafter, in one of the two years following (Figure 1). This window of time allows for possible delays in the climatic impact of eruptions (e.g., as volcanic sulphate is dispersed hemispherically or globally), and delays in the onset of societal stress and unrest, as may occur with state intervention (e.g., famine relief measures). While the high percentage of revolts occurring closely in time with volcanic eruptions suggests the reality of an underlying causal link (a key part of which can be posited as volcanically-driven Nile failure, in turn stressing societal systems), it is necessary to examine whether this apparent association between revolt onset and volcanic sulphate deposition in the Greenland ice is likely to have arisen simply by chance.

We thus conduct a permutation *t* test,[26] and find that the average number of years with volcanic sulphate deposition in the (combined) years of revolt onset

ther differentiate the character of unrest, e.g., spontaneous vs. organized, localised vs. widespread.

26 More formally, we use a Monte Carlo equal means test (100,000 iterations) as an alternative to the standard parametric Student's *t* test because it requires fewer statistical

and the two preceding years is greater than expected randomly at 97.8% confidence ($p = 0.022$). Put differently, the probability that this result has occurred by chance is 2.2%. Repeating our test to examine the robustness of this result using a smaller window, we also find that the average number of years with volcanic sulphate deposition in the combined years of revolt onset and the first single preceding years is greater than expected randomly at 97.7% confidence ($p = 0.023$). These results strongly support the reality of a link between eruptions and internal revolt onset in the Ptolemaic period.[27]

2 Conclusions

The Hellenistic era of eastern Mediterranean history was a time of massive military mobilization for interstate conflict, driven by the dynamics and rivalries of post-Alexandrian state formation. Internally in Egypt, the imposition of a new, more tightly controlled and extractive fiscal system, inter-ethnic tensions, state sponsored increases in the production of free-threshing wheat at the expense of hardier emmer wheat, and the burden of military mobilization are likely to have introduced new fault lines and vulnerabilities (some latent, others more quickly manifest) in Egyptian society. In an agrarian economy critically dependent on the summer Nile flood, the considerable level of volcanic activity in the third and second centuries BCE is likely to have played an important role in weakening the Ptolemaic state.

The connection between volcanic eruptions, climate forcing and the cascading impacts of climatic and hydrological shocks on human society has been studied for other regions and periods,[28] but the impact of eruptions on agriculture and society in the Ancient Mediterranean world merits further study.[29] For Ptolemaic Egypt, the role of hydrological shocks has not been explicitly

assumptions of our data, being robust, for example, to non-normality. We enact the test following Hammer et al. (2001) and Hammer and Harper (2006), and report one-tailed *p* values.

27 For reference, the average number of years between 305 and 30 BCE that register volcanic sulphate deposition in the NEEM ice-core is 0.16 (i.e., 16% of years register deposition across the full period). By contrast, we see an average of 0.26 when only counting deposition during the combined years of, and first two years preceding, revolt onset. When only counting the combined years of, and first single years preceding, revolt onset, we see an average of 0.27.

28 As examples, see McCormick et al. (2007) for Europe, and Fei and Zhou (2006) and Fei et al. (2007) for Asia.

29 See Horden and Purcell (2000, Chapter 8).

raised as an ongoing trigger for interval revolt. What emerges from our initial work is that volcanic climate forcing associated with presumed Nile failure (via suppression of the East African Monsoon) is likely to have played upon and exacerbated existing problems, with many revolts aligning closely in time with volcanic sulphate deposition in Greenland. Certainly, we do not believe that positing a simple link between eruptions, Nile failures and social unrest is a sufficient causal model. Nor do we believe that the "revolts" of the Ptolemaic period were of a single kind. Rather, what we see in the sources is a wide spectrum of unrest ranging from small, localized events (e.g., food riots) to large-scale mobilization in rural areas against Ptolemaic rule. The broad range of possible disturbances is indeed reflected in the various terms used for unrest in the Greek papyri, and we hope to better understand the character of social unrest through a more critical, detailed examination of known events.

The chronology of revolts, which, because of the nature of our sources, is sometimes vague, also requires refinement. It seems plausible that some individual revolt dates taken from Veïsse (2004) form part of already-ongoing revolts. Veïsse's useful study breaks down the revolt years by region when a global view may be preferable for some purposes. We know, for example, that there was a problem in the Delta (at Lykopolis) in 197 BCE because it is mentioned in Rosetta stone. But it seems likely that the unrest noted there was part of the wider Theban revolt of ca. 207–186 BCE.[30] To further characterize the statistical association between hydrological shocks and internal revolt it will thus be important to distinguish the likely start dates of distinct revolts from dates that may form part of established revolts, given that hydrological shocks can be more plausibly hypothesized to act as initial triggers for revolts, rather than as mechanisms for sustaining them across multiple years.[31]

It must also be noted that the Ptolemaic state showed considerable resilience in responding to the hydrological shocks likely to have occurred repeatedly in this volcanically active period. These shocks would, indeed, have been superimposed upon the already notable variability of the Nile, also responsive to global patterns of climatic variability such as the sign and strength of the El Niño Southern Oscillation (ENSO) (Davis, 2001). The 238 BCE Canopus Decree shows that Ptolemy III was able to import grain into Egypt from externally controlled rain-fed territory, and reference to new irrigation machines

30 There is a widespread lack of clarity in the literature concerning the cited onset date of the Theban revolt, with dates ranging from 207 to 205 BCE. See footnote 25.

31 An additional hypothesis worth pursuing is that hydrological shocks may have intensified ongoing revolts. Testing this will again necessitate a more fine-grained understanding of the internal revolts in the Ptolemaic period.

begin to appear in the historical record, and can be seen in the archaeological record. However, the Ptolemaic shift to naked wheat reduced diversity in Egypt's subsistence base and increased the risk of adverse *portfolio effects* for wheat.[32] Later losses of external territory diminished the capacity of the state to respond to crises by importing grain. While many hypotheses have been advanced to explain the course of the state's history, including its early success, internal revolts, inter-state warfare and its gradual decline in the face of rising Roman imperial ambitions, it is striking that the role of abrupt climatic shocks has been ignored for a society so dependent upon the climatically-sensitive Nile summer flood. The Ptolemaic regime's formal end came after the defeat of Antony and Cleopatra by Rome at Actium in 31 BCE. It is notable that this occurred shortly after the near-simultaneous occurrence of an extratropical northern hemispheric eruption in ca. 46 BCE and a tropical eruption in ca. 44 BCE that represents the third largest eruption of the past 2,500 years in its estimated climate forcing impact,[33] with a further extratropical northern hemispheric eruption in ca. 35 BCE (Sigl et al., 2015).

The Ptolemaic state did not exist in isolation; one of the hallmarks of the Hellenistic period is the great intensity of interaction throughout and beyond the Mediterranean. This interaction was cultural and economic, but also military, as in the series of "Syrian Wars" between the Ptolemaic and Seleukid states from 274 to 168 BCE (Grainger, 2010). Examination of the environmental context of the greater Hellenistic world may shed further light on the dynamics of such interactions; important here will be understanding how volcanic eruptions of this period influenced the climate of the Eastern Mediterranean and SW Asia, and in turn impacted the hydrology of the region's other great rivers. Rivers such as the Tigris and Euphrates irrigated core regions and settlements of the Seleukid state with water from their headwaters in the Taurus Mountains (Turkey). Large eruptions are known to significantly perturb the winter westerlies (Robock, 2000), the positioning of which influences the volume of winter snowfall and precipitation over the Taurus Mountains that is available to supply the Tigris and Euphrates (Cullen and deMenocal, 2000). The Seleukid state may also therefore have been vulnerable to volcanically-triggered hydrological shocks. It cannot be assumed, however, that this vulnerability was evenly balanced with the Ptolemaic state, and asymmetrical vulnerabilities may have formed part of the dynamics underlying the Syrian Wars. It can also be noted that the environment was itself greatly affected by the Hellenistic states. Some

32 See Schindler et al. (2010) for discussion of the concept of portfolio effects.

33 And see Bicknell (1993) and Sigl et al. (2015) for historical reporting of the dust-veil likely associated with this event, as well as societal impacts.

changes (e.g., draining and reclamation of land in the Fayyum depression to the southwest of the Nile Delta in the middle of the third century BCE, trebling the available arable land there (Manning, 2003)) may themselves have been partly motivated by environmental pressures such as Nile failure, in an example of a human-environmental systems feedback.

More broadly, volcanic eruptions can act as an historiographical tool, as "revelatory crises" (Solway, 1994) that provide test-cases of societal response to sudden climatic shocks in different eras and regions, and may reveal underlying vulnerabilities and fault-lines (ethnic, economic, political) that are latent and otherwise difficult to discern. Even a cursory review of the historical record reveals further possible correspondences between eruptions, revolt and unrest that suggest Nile failure's recurrent role as a trigger. Unrest during the period of Persian rule in Egypt is usually deemed the product of "opportunistic" uprisings during times of dynastic weakness (Kahn, 2008; Ruzicka, 2012:29). Two of the best-documented revolts, those of 486–484 and 464–462 BCE occur in the aftermath of eruptions dated to ca. 487 (extratropical Northern Hemisphere) and ca. 465 BCE (tropical) (Sigl et al., 2015). Centuries later, during the period of Roman control of Egypt, the "Revolt of the Boukoloi" ("herdsmen") ca. 167–169 CE may be associated with a major tropical eruption in ca. 168 CE. This revolt has generated much discussion, mainly on the basis of the literary texts that make mention of it, and is well summarized by Blouin (2014). *P. Thmouis* 1, provides a valuable, documentary perspective of the historical nature of the revolt. Blouin (2014:269) places this text front and center, and sets the revolt in the context of the "long term socio-hydrological pressures and Roman-period agro-fiscal dynamics". Interestingly, as in some Ptolemaic texts, the rebels are referred to as "impious." In contrast to the near contemporary literary treatment of the "herdsmen" as evil-doers coming from dangerous, marshy, liminal regions of Egypt, Blouin, rightly in our view, frames the discussion in terms of a coupled social-environmental system, and our preliminary work here suggests the veracity of Blouin's thesis.[34]

34 We intend in future work to systematically revise and add data to Bonneau's (1971) study of the quality of the Nile summer flood during the Ptolemaic period, using texts published after 1970 as well as from the Demotic material that Bonneau did not consider.