

## How Disease Affected the End of the Bronze Age

### THE ANCIENT NEAR EAST 1700–1150 BCE: A GEOPOLITICAL BACKGROUND

The Ancient Near East was the region home to early civilizations that were so important in the development of human society, and is referred to as the “Cradle of Civilization”. The Ancient Near East region covered the modern Middle East including Mesopotamia (modern Iraq), Ancient Egypt, Ancient Iran, Anatolia/Asia Minor (modern Turkey), The Levant (modern Syria, Lebanon, Israel, Palestine and Jordan) and the Arabian Peninsula. For the purposes of this book, the region has been expanded to include the Eastern Mediterranean region adjacent to the Near East which includes Greece, Crete and Cyprus.

The Ancient Near East was characterized by being the first to practice intensive year-round agriculture, developing the first writing system, inventing the potter’s wheel and mill wheel, pioneering centralized governments, law codes and empires. The Ancient Near East also introduced organized warfare, slavery and the stratification of societies, as well as laying down the foundations of the fields of astronomy and mathematics.

The Ancient Near East and Middle East Periodization Chart (Table 5.1) shows Near Eastern and Middle Eastern history divided into eras.

The focus of this book is the period from 1700 BCE when the Hittite Empire began until 1150 BCE when the Bronze Age in the Near East officially ended (the end being between 1200 to 1150 BCE). As can be seen

Table 5.1 Ancient Near East and Middle East Periodization Chart

<b>Copper Age</b>	Chalcolithic (4500–3300 BCE)	Early Chalcolithic Late Chalcolithic	4500–4000 BCE 4000–3300 BCE	Ubaid period Ghassulian, Uruk period, Gerzeh, Predynastic Egypt
<b>Bronze Age</b> (3300–1200 BCE)	Early Bronze Age (3300–2000 BCE)	Early Bronze Age I Early Bronze Age II Early Bronze Age III	3300–3000 BCE 3000–2700 BCE 2700–2200 BCE	Protodynastic to Early Dynastic Period of Egypt Early Dynastic Period of Sumer Old Kingdom of Egypt, Akkadian Empire
	Middle Bronze Age (2000–1550 BCE)	Early Bronze Age IV Middle Bronze Age I	2200–2100 BCE 2100–2000 BCE	First Intermediate Period of Egypt Middle Kingdom of Egypt and end of Sumert
	Late Bronze Age (1550–1200 BCE)	Middle Bronze Age IIA Middle Bronze Age IIB Middle Bronze Age IIC Late Bronze I Late Bronze Age IIA	2000–1750 BCE 1750–1650 BCE 1650–1550 BCE 1550–1400 BCE 1400–1300 BCE	Minoan civilization and Beginning of End of Indus Valley Civilization Second Intermediate Period of Egypt Hittite Old Kingdom, Minoan eruption Hittite Middle Kingdom Hittite New Kingdom, Mitanni, Ugarit and End of Indus Valley Civilization (Dark Age, Sea Peoples)
<b>Iron Age</b> (1200–539 BCE)	Iron Age I (1200– 1000 BCE) Iron Age II (1000–539 BCE)	Late Bronze Age IIB Iron Age IA Iron Age IB Iron Age IIA Iron Age IIB Iron Age IIC	1300–1200 BCE 1200–1150 BCE 1150–1000 BCE 1000–900 BCE 900–700 BCE 700–539 BCE	Troy V II, Hekla 3 eruption Neo-Hittite states Neo-Assyrian Empire Kingdom of Israel, Urartu, Phrygia Neo-Babylonian Empire

from this chart, this time period includes the Second Intermediate Period of Egypt, the Hittite Old Kingdom, Minoan Eruption, the Hittite Middle Kingdom, The Hittite New Kingdom, Mitanni and Ugarit Kingdoms, the Sea Peoples, Troy VII and the Hekla 3 eruption followed by the post End of the Bronze Age Neo-Hittite states in the remains of what was the Hittite Empire.

In 1700 BCE the Ancient Near East was dominated by Egypt in the Nile Valley and into the Levant, the Kingdom of Babylon in Mesopotamia and the Minoan civilization in Crete. Anatolia was made up of small city-states including Arzawa.

Egypt and Babylon's military tactics were based on foot soldiers and were no match for the hordes of invaders who came from the Central Asian plains and swept through the Near East. They came in fast two-wheeled horse-drawn chariots with a driver and an archer on board. This system of weaponry was developed and refined earlier, during years of warfare on the plains of Central Asia. This type of weapon or style of warfare was unknown among the classical oriental civilizations. The foot soldiers of Egypt and Babylonia were unable to defend against these invaders. In 1630 BCE, the Hyksos swept into the Nile Delta region, and in 1595 BCE the Hittites swept into Mesopotamia.

The Middle Bronze Age civilizations c.1700 BCE displayed all their characteristic social traits: a low level of urbanization due to an agricultural based society; small cities centered around royal palaces; numerous temples; a strict separation of classes between an illiterate mass of peasants and craftsmen and a powerful military elite. Knowledge of writing and education was reserved to a small minority of scribes and the aristocrats.

Developments in the ancient Near East after 1700 BCE include the Hittite Empire beginning c.1700 BCE, in c.1600 BCE the Minoan civilization reached its peak and Mycenae in Greece was occupied with the Mycenaean civilization flourishing until c.1200 BCE. In c.1450–1500 BCE the Mitanni Kingdom in northern Mesopotamia began, Minoan culture ended on Crete and the Kassites ruled Babylonia. Later the Mitanni Kingdom was divided in two with the western half taken over by the Hittite Empire and the eastern half taken over by the Assyrians.

At the end of the Bronze Age between 1200 and 1150 BCE only the Egyptian Empire remained with all other empires, kingdoms and city-states having been destroyed in the "catastrophe".

## THE BRONZE AGE AND IRON AGE: A SUMMARY

Human cultural development can be measured by means of the types of materials used to make tools, utensils and weapons. First there was the Stone Age where hard flint stone was sharpened by chipping away and honing the cutting edge on another flint stone. This resulted in a sharp cutting edge, which could be used as a knife, axe or spear tip.

The next stage was the Copper Age, the first of the metal ages. Copper by itself is a relatively soft metal; so copper-only metal implements were weak. So the metal workers looked for ways to make the copper stronger. Through trial and error they arrived at the idea of mixing or alloying small quantities of tin with the copper to form bronze.

The dates for the Bronze Age varied from region to region depending on the region's copper and tin ore supplies or that region's ability to trade for bronze ingots. For example, the Bronze Age in the Near East (the region of interest in this book) went from c.3300–1200 BCE, while in South Asia it was from 3000–1200 BCE, in Europe 2300–600 BCE, in China 2000–700 BCE and in Korea 800–400 BCE. By contrast the Sub-Saharan African region bypassed the Bronze Age altogether going from the Stone Age directly to the Iron Age with the use of imported iron, because the region had no copper or tin mines and no ability to trade for bronze. Some cultures went straight from the Stone Age to the Iron Age, bypassing the Copper and Bronze Ages, when their culture was infiltrated by immigrants who brought Iron Age tools with them; such as when the British colonized Australia, New Zealand and Fiji.

Focusing on Ancient Near East, the Near East had the earliest Bronze Age because “Metallurgy developed first in Anatolia, modern Turkey. The mountains in the Anatolian highland possessed rich deposits of copper and tin”.<sup>1</sup> Copper was also found in Cyprus, the Negev Desert and Iran. Tin was found in more distant places such as far off Cornwall (UK) and the North West Indian subcontinent, so trade in tin became a vital trade route commodity.

The Near Eastern Bronze Age has been divided into the Early Bronze Age (c. 3300–2000 BCE), Middle Bronze Age (c. 2000–1600 BCE) and the Late Bronze Age (c. 1600–1200 BCE) by scholars. A more detailed dating system is shown in Table 5.2.

The next stage in human cultural development was the Iron Age; this is the third and final stage in the usual three-stage sequence of Stone Age,

**Table 5.2** Bronze Age dating

<b>Bronze Age</b> (3300–1200 BCE)	Early Bronze Age (3300–2200 BCE)	Early Bronze Age I	3300–3000 BCE
		Early Bronze Age II	3000–2700 BCE
		Early Bronze Age III	2700–2200 BCE
	Middle Bronze Age (2200–1500 BCE)	Middle Bronze Age I	2200–2000 BCE
		Middle Bronze Age IIA	2000–1750 BCE
		Middle Bronze Age IIB	1750–1650 BCE
		Middle Bronze Age IIC	1650–1550 BCE
	Late Bronze Age (1550–1200 BCE)	Late Bronze Age I	1500–1400 BCE
		Late Bronze Age IIA	1400–1300 BCE
Late Bronze Age IIB		1300–1200 BCE	

Pernicka, E. et al., “*Early Bronze Age Metallurgy in Northeast Aegean*”, in Wagner, G.A. et al. (eds), *Troia and Troad: scientific approaches, natural science in archaeology*, (Berlin, London: Springer, 2003) 143–172

Bronze Age and Iron Age or the fourth in the more detailed five-stage sequence of Stone Age, Copper Age, Bronze Age, Iron Age and Steel Age. The Iron Age ended in each region with the beginning of what is known as the historical period, that is, the local production of sufficient detailed written sources and records.

Again the dates for the Iron Age vary from region to region depending on that region’s access to iron ore mines. Again Anatolia was blessed with abundant iron ore in its mountains. Consequently the Ancient Near East had the earliest Iron Age from 1300 to 600 BCE followed by India 1200–200 BCE and Europe 1200–400 BCE, China 600–200 BCE, Korea 400–50 BCE and Japan 100 BCE–500 CE.<sup>2</sup> Other historians give earlier dates for the Iron Age in Anatolia saying the earliest iron ware dates from about 2000 BCE<sup>3</sup> and forged weapons at the latest by 1500 BCE.<sup>4</sup>

According to the late eminent Oxford historian John Morris Roberts when discussing the Hittite Empire, he stated it “enjoyed a virtual monopoly of iron in Asia, this not only had great agricultural importance but, together with their mastery of fortification and the chariot, gave the Hittites a military superiority which was the scourge of Egypt and Mesopotamia”.<sup>5</sup> Also “the use of iron weapons by the Hittites was believed to have been a major factor in the rapid rise of the Hittite Empire”.<sup>6</sup> By 1200 BCE, iron was in common use around the Middle East but it would take a few more centuries before it supplanted bronze as the dominant metal even though it was lighter and stronger.

One theory for the collapse of the Bronze Age was a lack of tin either due to it having been mined out or because its trade routes had been disrupted due to raiders,<sup>7</sup> thus forcing metalworkers to look for an alternative metal. Hence iron became the next preferred metal. Another explanation for the end of the Bronze Age is simply that iron, once discovered, was found to be a better metal because it was much stronger.

A Hittite tomb in Anatolia housed a dagger that had a smelted iron blade dating from 2500 BCE, making it one of the earliest ever examples of smeltered iron.<sup>8</sup> The Late Bronze Age saw the slow continuous transition from bronze to iron throughout the Near East region as price and availability of iron, not just the iron-making technology above, determined the rate of expansion of iron usage. Thus it was a gradual transition from late Bronze Age to early Iron Age over several centuries in the Near East around 1200 BCE.

## CURRENTLY ACCEPTED CAUSES FOR THE END OF THE BRONZE AGE: A SUMMARY

### *Introduction*

The end of the Hittite Empire occurred c.1200 BCE<sup>9</sup> and was part of a much larger event—the end of the Bronze Age. The end of the Bronze Age was known as the “catastrophe”<sup>10</sup> because it signaled the end of all the known empires in the Eastern Mediterranean and Near East including the Hittite Empire, the Mycenaean Kingdoms and the Egyptian Empire in Syria and Canaan, but not the central Nile based Egyptian Empire. It was followed by the “Ancient Dark Age” when all that was glorious about these lost empires including, not only their palaces and cities but also their history, religions, writings, art, music, administration and organization, temples, libraries, political systems and trade routes were lost. This loss lasted many centuries until the emergence of the classical Greek, Assyrian and Persian Empires and the Hebrews later.

The catastrophe lasted from c.1200–c.1150 BCE and was characterized by its short time frame of about 50 years, mass migrations of populations and mass destruction where whole cities were destroyed and burnt, but also curiously many whole cities were just abandoned intact. It was also characterized by another mass population migration involving raiders called the “Sea Peoples” who invaded the Near East from the Mediterranean region. It was “violent, sudden and culturally disruptive”.<sup>11</sup>

The Dartmouth University Archaeology Department has an online lesson about the collapse of the Mycenaean Palatial Civilization in Greece around 1200 BCE. It summarizes the causes of this collapse as: economic factors, climate change, internal social upheaval, invasion from outside the Aegean World and changes in the nature of warfare.<sup>12</sup>

Historian Robert Drews in his book *The End of the Bronze Age* has on his list of possible causes of the collapse the following: earthquakes, mass migrations, ironworking, drought, systems collapse, raiders and changes in warfare.<sup>13</sup>

The internet website, [www.enotes.com](http://www.enotes.com), lists the possible causes for the Bronze Age Collapse, which includes the following: volcanoes, earthquakes, migrations, raids, ironworking, drought, changes in warfare and general systems collapse.<sup>14</sup>

Note that there is no mention of disease as a possible cause of the End of the Bronze Age in any of these three lists. By contrast this book proposes the more comprehensive list of sixteen causes for the end of the Bronze Age, including diseases.

But the final answer for the causes of the end of the Bronze Age will be multifactorial as some things will apply to one area, such as earthquakes in Greece that do not apply to other areas. A possible major cause though, one that knows no boundaries or political borders when it spreads are infectious disease epidemics. So what is the evidence?

### *Volcanoes*

Mt. Hekla is a volcano located on the southern side of Iceland. According to volcanologists and Egyptologists, it erupted in 1159 BCE throwing an estimated “7.3 cubic km of volcanic rock into the atmosphere, placing its Volcanic Explosivity Index (VEI) at 5. This would have blocked out the sun leading to cooler temperatures in the northern parts of the globe for a few years afterwards. Thus plants would not grow causing famine and eventual disease in the weakened population. Traces of this eruption have been identified in Scottish peat bogs, and in Ireland a study of tree rings dating from this period has shown negligible tree ring growth for a decade”.<sup>15</sup>

The Volcanic Explosivity Index is a relative measure of the explosiveness of a volcanic eruption on a scale of 1–8, with 8 being a mega-colossal

eruption where the cloud column of ejected material would climb to a height of over 50 km. Such a large volcanic eruption could have caused famine in the Near East contributing to the demise of the region. The scale is logarithmic where each interval on the scale represents a ten-fold increase in the material ejected. By comparison the largest volcanic eruption in recent history was Mt. Krakatoa in 1883 which had a Volcanic Explosivity Index of 6, and Mt. Vesuvius which destroyed Pompeii in 79 had a Volcanic Explosivity Index of 5.

### *Comets*

Mike Baillie is the Emeritus Professor of Paleoecology at the Queen's University in Belfast, Northern Ireland and is an expert of Dendrochronology, which is the science of dating by means of tree rings. He has built a year by year chronology of tree ring growth reaching back "the last 5,000 years".<sup>16</sup>

His work has confirmed "that the events such as those at 1628 BC, 1159 BC and AD 540, represented abrupt environmental downturns with profound effects on human populations".<sup>17</sup> These dates correspond with dynastic changes in China, the end of the Bronze Age in the Near East and the Plague of Justinian, respectively. These events were most likely volcanic in cause but he also argues that it could also be due to the impact of debris from comets blocking out the sun and causing temperatures to fall for years, hence poor growth in trees, as shown in their tree rings, and all other plants leading to famine which makes the general population more prone to disease. This has been formalized in his paper "Hints that Cometary Debris Played some Role in Several Tree Ring Dated Environmental Downturns in the Bronze Age".<sup>18</sup>

### *Earthquakes*

Amos Nur is the Emeritus Professor of Geophysics at Stanford University, California, USA and he:

postulates that earthquakes tend to occur in "sequences" or "storms" where a major earthquake above 6.5 on the Richter magnitude scale can in later months or years set off second or subsequent earthquakes along the weakened fault line. He shows that when a map of earthquake occurrence is



superimposed on a map of the sites destroyed in the late Bronze Age, there is a very close correspondence.<sup>19</sup>

In his paper “The End of the Bronze Age by Large Earthquakes?”<sup>20</sup> Nur proposes that a large earthquake storm lasting 50 years from c.1225 to c.1175 BCE could have contributed to the End of the Bronze Age.

Twentieth-century geophysical data about the geography of active tectonic faults especially at geological plate boundaries, the location of earthquakes, the geography of ground motion intensity, and earthquake frequency-magnitude statistics in the eastern Mediterranean show that most of the sites that collapsed at the end of the Bronze Age must have experienced destructive earthquakes repeatedly in their past. Recent and historical evidence shows also that these massive earthquakes reoccur every few hundred years in bursts, or “storms” of large events that sweep across broad portions (500–2000 km in length) of the eastern Mediterranean and over short periods of time (50 years).

This suggests that a large earthquake could have contributed to (and probably did contribute to) both the physical and political collapse of the great centers of civilization at the end of the Bronze Age. This probably began by an earthquake storm that unzipped the plate boundaries in the eastern Mediterranean between 1225 and 1175 BCE. The earthquakes in this 50-year long storm could have rendered many of the urban centers militarily vulnerable, thus inviting attacks, not by powerful distant Sea People but by opportunistic indigenous or neighboring populations. These attacks may have led in turn to the political and social collapse of the centres, followed by a dark age of recovery and rebuilding often lasting a few hundred years.<sup>21</sup>

Figure 8 of Nur’s paper shows “Superposition of the sites destroyed at the end of the Bronze Age in 1200 BC and the earthquake intensity VII in our century (1910–1980). The coincidence suggests that the end of the end of the Bronze Age could be related to earthquakes”.<sup>22</sup> (See the table of Bronze Age Earthquake Destruction in Nur’s paper.)<sup>23</sup>

Drews in his book *End of the Bronze Age* dismisses the idea of earthquakes totally. He says that archaeologists only look at their own site and an earthquake may be relevant only to this site and not the whole of the Eastern Mediterranean. Nur, on the other hand, has shown that earthquakes occurred all over the Eastern Mediterranean and Near East.

Elizabeth B. French is an authority in Mycenaean Pottery and a former Warden of Ashbourne Hall, Manchester University and the former Director of the British School of Athens, from 1989 to 1994, which is a facility established in 1886 to promote British-based Greek archaeological research and study. In 1996 French wrote:

Archaeologists of my generation, who attended university in the immediate aftermath of Schaeffer's great work in 1948, were brought up to view earthquakes, like religion as an explanation of archaeological phenomena to be avoided if at all possible. Thus, it is only recently that an earthquake at Mycenae has begun to be a serious hypothesis.<sup>24</sup>

Claude Frederic-Armand Schaeffer (1898–1982) was the first to conduct the excavations at the ancient city Port of Ugarit at Ras Shamra in Syria from 1929 that showed that the city was destroyed c.1190 BCE by the invading Sea People as told by Ammurapi, the King of Ugarit, in a letter to the King of Alasiya.

In 1948, Schaeffer first suggested that an earthquake may have destroyed late Bronze Age sites. His idea was rejected by archaeologists because the catastrophe was spread over a 50-year period and could not have been the result of a single earthquake. Schaeffer did not know then about 50-year long “earthquake storms” as proposed by Nur, which have put earthquakes back on the agenda. Schaeffer was a French scholar and archaeologist who was the curator of the Prehistoric and Gallo-Roman seum in Strasbourg (1924–1933) and the Museum of National Antiquities in Saint-Germain-en-Laye (1933–1956).

Fritz Schachermeyr (1895–1987) was an advocate for earthquakes playing a role in the end of the Bronze Age, which he proposed in his book *Griechische Frühgeschichte*.<sup>25</sup> He has a similar view to Nur in advocating that catastrophic earthquakes destroyed Troy in Western Turkey, Mycenae in Greece and Knossos in Crete about 1200 BCE. Fritz was a professor specializing in ancient history and more specifically in Ancient Greek. He was a professor at Jena University (founded in 1558) in 1931, Heidelberg University (founded in 1386) in 1936, University of Graz (founded in 1585) in 1940 and finally the University of Vienna (founded in 1365) in 1952 until his retirement.

### *Tsunamis*

Tsunamis usually accompany an underwater earthquake or volcanic eruption. So in line with the above evidence about earthquakes and volcanoes then a destructive tsunami may also have occurred, such as when the volcano on the island of Thera erupted sending a massive tsunami to Crete destroying many Minoan coastal settlements.

### *Mass Migrations of Populations*

During the catastrophe many new ethnic groups started to appear in the Near East region.

Indo-European tribes such as the Phrygians, Thralians, Proto-Armenians, Macedonians and Dorian Greeks seem to have arrived at this time—possibly from the north. There also seems to have been widespread migration of the Aramaeans, possibly from the South East.<sup>26</sup>

The people involved in the mass migrations could have been “pushed” by drought and subsequent famine, earthquake destruction, raiders, and “Sea People” invasions. They could also have been “pulled” by the prospect of better lands and food, plus safety being far away from raiders. Another one of the possible “push” scenarios could be fleeing disease, and this should be factored in by historians.

### *Raids and Invasion by the “Sea Peoples”*

The “Sea Peoples” is the name given to a confederacy of seafaring raiders who invaded the Eastern Mediterranean at the time of the catastrophe. They invaded Cyprus, the Hittite Empire and the Levant. They also tried to invade Egypt but were repelled. The Pharaoh Merneptah (reigned c.1213–c. 1203 BCE) referred to them as “the foreign countries or peoples of the sea” in his Great Karnak Inscription.<sup>27</sup> He fought and defeated them at Perire, in the western Nile Delta during the fifth and sixth years of his reign.

Later the Great Pharaoh Ramesses III (reigned c.1182–c. 1151 BCE) had to deal with a later wave of invasions by the Sea Peoples. The following inscription from his Medinet Habu mortuary temple describes what happened, who they conquered and who made up their confederation force:

The foreign countries (i.e. Sea Peoples) made a conspiracy in their islands. All at once the lands were removed and scattered in the fray. No land could stand before their arms: from Hatti, Qode, Carchemish, Arzawa and Alashiya on, being cut off (i.e. destroyed) at one time. A camp was set up in Amurru. They desolated its people, and its land was like that which has never come into being. They were coming forward toward Egypt, while the flame was prepared before them. Their confederation was the Peleset, Tjeker, Shekelesh, Denyen and Weshesh, lands united. They laid their hands upon the land as far as the circuit of the earth, their hearts confident and trusting: ‘Our plans will succeed!’<sup>28</sup>

Ammurapi was the last Bronze Age King of Ugarit. He wrote a letter to the king of Alasiya telling how the Sea Peoples had invaded and destroyed his country:

My father, behold, the enemy’s ships came (here); my cities (?) were burned, and they did evil things in my country. Does not my father know that all my troops and chariots(?) are in the Land of Hatti, and all my ships are in the Land of Lukka? ... Thus the country is abandoned to itself. May my father know it: the seven ships of the enemy that came here inflicted much damage upon us?<sup>29</sup>

The Sea People, like the other mass migrations, may have been “pushed” out of their lands by earthquakes, drought, and famine; and “pulled” to new lands looking for food and minerals such as iron, tin and copper. They too may have been “pushed” out of their lands by infectious disease. There are many hypotheses about who were the “Sea Peoples”.

1. *Philistine hypothesis*: The Hebrews called the southern coastal plain of ancient Palestine “Philistia” and the people who lived there in the five towns called the “Philistine Pentapolis” of Askelan, Ashdod, Ekron, Gath and Gaza were called “Philistines”. There are two schools of thought as to their origin. One school says they were Mycenaean because they made distinctive Mycenaean III C pottery, whereas the other school says they were an indigenous Canaanite culture. Either way they became a force that helped attack Egypt as part of the “Sea Peoples”.
2. *Minoan hypothesis*: After the eruption of the volcano at Thera (today’s Santorini), sometime between 1660–1613 BCE, Crete would have been devastated by fires and ash causing a cooling climate resulting in crop failures and famine, plus the tsunamis

destroying the coastline. The people of the Minoan culture would have been forced to leave Crete, some scholars say initially to Anatolia and from there later to the Levant as “Sea Peoples”.

3. *Greek migration hypothesis*: Greece not only possibly supplied people for the Philistines but also supplied people who migrated to Sicily and Sardinia as well as fought in Troy and later occupied Cyprus. So they would have been bands of raiders/invaders like the Sea Peoples.
4. *Trojan hypothesis*: Historian Eberhard Zangger proposes that the “Sea Peoples” may have come from Troy and its allies, and that the Greek literary tradition of the Trojan War, as told by the poet Homer, may well reflect the Greek efforts to counter those raids.<sup>30</sup> Zangger (1958) is a Swiss German who has a PhD in natural sciences from Stanford University and was a senior research associate in the Department of Earth Sciences at the University of Cambridge from 1988–1991. He is a writer on geoarchaeology especially in the pre-historic Aegean area.
5. *Mycenaean warfare hypothesis*: In this hypothesis the Greek Mycenaean city states fought each other over decades. Refugees from this fighting then turned to piracy for survival and that this in turn led to becoming “Sea Peoples” raiders.
6. *Italian peoples hypothesis*: Italy may have supplied some of the Sea Peoples from the Etruscans.
7. *Anatolian famine hypothesis*: In this hypothesis extensive drought in Anatolia, which led to famine, in turn forced people from places in Anatolia such as Lydia to go to sea and become sea-going migrants. These displaced people could later become Sea Peoples.

A famous passage from Herodotus portrays the wandering and migration of Lydians from Anatolia because of famine: In the days of Atys, the son of Manes, there was a great scarcity through the whole land of Lydia ... So the King determined to divide the nation in half ... the one to stay, the other to leave the land ... The emigrants should have his son Tyrrenus for their leader ... They went down to Smyrna, and built themselves ships ... After sailing past many countries they came to Umbria ... and called themselves ... Tyrrenians.<sup>31</sup>

8. *Invader hypothesis*: Historian Michael Grant proposed that there may have been another origin for the “Sea Peoples” besides the Aegean. He proposed that “There was a gigantic series of migratory waves, extending all the way from the Danube valley to the plains of China.”<sup>32</sup> Grant (1914–2004) received a Doctor of

Literature from the University of Cambridge and was an English classicist, numismatist and author of more than seventy books on ancient history and ancient coins.

Fellow historian Sir Moses I. Finley has suggested that the Carpatho-Danubian region of Europe was the original centre of this disturbance. Sir Michael Grant and Sir Moses I. Finley suggest that these people were invaders who destroyed sophisticated cities and built simpler and less complex settlements with plain pottery and simple tools, on top of the ruins. This demonstrates a cultural discontinuity<sup>33</sup> from a more advanced culture to a less advanced culture after the invaders or raiders took over. Sir Moses I. Finley (1912–1986) was born in the USA as Moses Israel Finkelstein but changed his surname to Finley in 1936. He studied at Syracuse University and Columbia University and taught ancient history at Columbia University and Rutgers University in the USA, specializing in the social and economic aspects of the ancient world. After being attacked for his left wing opinions by Senator Joseph McCarthy in 1954 he immigrated to Britain where he taught classics at the University of Cambridge from 1955, eventually becoming professor of ancient history from 1970 to 1979 when he was also knighted.

### *Ironworking*

The collapse of the Bronze Age should also be seen as part of the bigger technological picture and changes taking place at the time, that is, the slow change from bronze making to iron working. Even though the Hittites in Anatolia were the first great power to have iron at the time of the collapse, the general regional shift from bronze to iron occurred after the collapse of the Bronze Age c.1200 BCE.<sup>34</sup> The Sea Peoples' weapons for example were made of bronze, not iron. So iron confirmed the collapse and end of the Bronze Age but did not cause it.

### *Lack of Tin*

Bronze is made from a combination of 85–95% copper and 5–15% tin. In the ancient world tin was an element in short supply. Without tin the only metal available for implements and weapons was the much softer plain copper of the Copper Age.

The Near East had few tin mines with Anatolia being the main source of tin. The majority of the tin was imported from outside the Near East, with Cornwall in Britain and other sources to the distant East of the Near East, such as Afghanistan, being the main suppliers. Hence the tin trade and its trade routes were very important, like oil trade today. If the tin trade collapsed for whatever reason, such as war or disease, then the Bronze Age would finish, as people would have to look for alternative metals such as iron, also the Bronze Age could have ended because iron is a stronger hence better metal and would have replaced bronze as a metal of choice.

### *Drought*

Herodotus (c484–c425 BCE) was a Greek Historian who is regarded as the “Father of History”. He wrote a detailed history of the Greco-Persian wars called the “Histories” and he “was the first historian known to collect his materials systematically, test their accuracy to a certain extent and arrange them in a well-constructed and vivid narrative”.<sup>35</sup> He proposed that the Bronze Age ended because of a long drought that caused famine and social disruption.

Examples of grain shortages in the Hittite Empire and demands for urgent resupply of Hatti in the late Bronze Age, just before the end, were mentioned in the last chapter. Dendrochronological (tree ring) studies have shown drought years leading up to 1200 BCE. “Starting from 1209 BCE, we see indices smaller than 100 per cent, except for two years, 1205 and 1204 BCE. In addition there is a continuous decrease in indices in the last five years of the empire. Examining the tree rings shows the existence of dry years which contributed to drought on the lands”.<sup>36</sup>

Peter Ian Kuniholm founded the Aegean Dendrochronology Project in 1973 and has been its Director ever since. This project examines tree rings all over the Aegean and Near East to make up a chronology of the area from Neolithic time to the present. He has shown that in 1190 BCE trees grew at only 53.5% of their normal rate, in 1189 BCE at 61.1% and in 1188 BCE at 62% indicating three consecutive years of drought, which would lead to famine. Examination of the data presented in this paper shows that the occurrence of three such poor growth years in a row was rare.<sup>37</sup> Kuniholm is the Professor of Archaeology and Dendrochronology at Cornell University. He gained his BA at Brown University in 1958, his

MA at Vanderbilt University in 1963 and his PhD from the University of Pennsylvania in 1977.

Other researchers also support the arid climate change theory at the end of the Bronze Age. Anthropologist Brandon Drake from the University of New Mexico studied various parameters including Mediterranean Sea temperatures to show the change in the climate to much drier times at the end of the Bronze Age and early Iron Age.<sup>38</sup> By contrast, archaeologist Jennifer Moody studied the change in building structure over the Late Bronze Age period to show that buildings had verandas, and were airy with good ventilation to keep them cool because the climate became “significantly drier than previously”.<sup>39</sup>

### *Famine*

Naturally what follows drought is famine. As discussed above, there was correspondence between the Hittite King and the Egyptian Pharaoh about urgent grain shipments for Hattusa. Famine can drive people from their lands and could be one of the causes for the mass migrations seen at this time, and could also have pushed the Sea Peoples from their land in search of new territories with food.

Famine can also weaken people and make them more prone to disease. For example prior to the Black Death, which started in Europe in 1347, there was the Great Famine which lasted from 1315–1317 which greatly weakened the population of Europe. The Great Famine was not caused by drought, as in the end of the Bronze Age though, but by several years of excessive rain fall. During this time crops were flooded or could not be planted. Disease could also cause famine because the farmers or slaves necessary to work the fields would have died, hence crops would not have been planted or maintained, let alone harvested, which required considerable man power.

### *Changes in Warfare*

Robert Drews “suggests that these collapses occurred as the result of a fundamental change in the nature of warfare in this period”.<sup>40</sup> The horse drawn chariot with an archer behind the driver was introduced in the seventeenth and eighteenth centuries BCE and subsequently dominated the Near Eastern battlefields. They did not dominate in the Aegean as the topography was different being more rugged terrain with fewer large flat



areas suited to chariot warfare. These chariots were manned by a socially and economically privileged warrior elite (e.g. the Hittite Empire, the Mycenaean Kingdoms, city states of coastal Syria and the Levant (such as Ugarit), the Hurrian Kingdom of Mitanni, the Kassite Kingdom of Babylon etc).<sup>41</sup>

Drews argues that these large massed chariot formations involving sometimes thousands of chariots became vulnerable when they were harassed and killed by highly mobile, lightly armed infantry who used new and better weapons with great success. These new weapons included (a) the Aspis—a highly maneuverable small round shield 2–3 feet in diameter as opposed to the Sakos or large immobile shield; (b) the Javelin which had elliptical heads instead of a barb which allowed easy retraction hence reuse. Massed javelins thrown on the run using massed swarming formations were very effective against massed chariots; (c) The new Nave Type II sword which was about 70 cm long which “optimized both for slashing as well as stabbing or thrusting”<sup>42</sup> and finally (d) “The infantryman’s corslet, which protected the trunk, arose, along with greaves for protecting below the knees”.<sup>43</sup>

This new warfare meant that an entire elite social order of charioteers became redundant and were replaced by infantry and cavalry. This meant significant disruptions of the aristocracy and consequently the royal families.

Unfortunately Drews only provides a single answer solution to a very complex multicausal problem, hence is guilty of oversimplification. Also his approach does not apply to the Aegean where chariots were less dominant due to the hilly topography. After the end of the Bronze Age Mycenaean pottery continued to depict war chariots as part of the decoration thus confirming that they had not died out. This assumes that the potters were portraying only contemporary and not historical scenes.

### *General Systems Collapse*

The late Bronze Age Palatial Kingdoms all had fatal centralized, complex and top-heavy political structures, which made them vulnerable. This bureaucratic domination and top-heavy administration involved the use of a whole scribal class of record keepers and was highly specialized. It also involved the exploitation of the peasantry who funded the whole expensive top-heavy system with their taxes.

So when the system was stressed by famine, war or disease for example, it was unable to cope due to lack of funding to prop up “the system”. Once the administration was affected then other things such as trade became affected. Once trade in all important commodities such as tin, grain, olive oil, wine and timber was stopped, the end was inevitable. A weakened administration could also not handle other crises such as peasant revolts, defection of mercenaries, overpopulation and invasion by Sea Peoples.

The General Systems Collapse theory was first proposed by Joseph Tainter in his book *The Collapse of Complex Societies*.<sup>44</sup> He argued that societies collapse when their investment in their social complexity becomes unsustainable. This book proposes that one of the causes for the General Systems Collapse c.1200 BCE was infectious disease epidemics. Tainter (1949– ) is an American anthropologist and historian who gained his PhD in 1975 from North Western University. He is currently the Professor of Environment and Society at the Utah State University.

### *Cost of Maintaining an Empire*

Vast sums of money were needed to run an empire especially one with an expensive and large bureaucracy. Besides their administrative expense, there was the cost of the Royal Family and the large armies necessary not only to defend the empire but also to help expand it. Once the revenue from taxes dried up the system, lacking funding, collapsed. So this is a consequence of the the reduced income caused by peasants migrating and dying due to famine, war or disease, but not a cause of the end of the Bronze Age.

### *Economic Factors*

This theory put forward variously by Vermeule (1960),<sup>45</sup> Lakovides (1974)<sup>46</sup> and Betancourt (1976)<sup>47</sup> suggests that the piratical activity of the “Sea Peoples” would cripple trade routes, hence disrupt commerce so much as to bring down the late Bronze Age empires. The theory refers to a consequence of the “Sea Peoples” activity and not to why the “Sea Peoples” were active in the first place. So once again there is a theory which turns out to be a “consequence of” and not a “cause of” the end of the Bronze Age.

### *Internal Fighting Within Ruling Royal Families*

The Hittite royal families provide many examples of internal fighting within a royal family. Murder, even of the incumbent king as a means to gaining control of the throne, was accepted practice. Fighting between different branches of the royal families leading to civil war would have badly destabilized any empire.

### *Disease*

William H. Stiebing, Emeritus Professor of History at the University of New Orleans, in his book *Ancient Near Eastern History and Culture* he stated in chapter 8 “The End of the Bronze Age” that “Something disturbed the fragile economic, social, and political systems of Bronze Age states and set off a series of chain reactions ... [That] ... destroyed the eastern Mediterranean Bronze Age civilizations.”<sup>48</sup> Stiebing includes the word “plagues” in his list of possible causes but does not elaborate any more on the subject.

Marc Van De Mieroop, Professor of History at Columbia University, says in his book *A History of the Ancient Near East* that “No single cause can explain this comprehensive change.”<sup>49</sup> When trying to explain the end of the Bronze Age.

Oliver Dickinson from Durham University had a similar view when he stated in chapter 36 “The Collapse at the end of the Bronze Age” in his contribution to *The Oxford Handbook of The Bronze Age Aegean (c3000–1000 BC)* that “it is a waste of effort to try to isolate a single cause or prime mover for the Collapse.”<sup>50</sup> This is because it was most probably the result of several causes.

This is what this book is arguing that the end of the Bronze Age in the Near East, referred to as either “The Catastrophe” or “The Collapse” [Dickinson preferred the term Collapse], was the result of a cascade of events beginning with volcanic eruptions and comets. These caused drought which in turn caused famine, which weakened the population so they (rich and poor alike, because disease does not discriminate) were prone to whatever infectious disease happened to be prevalent at the time. This is in agreement with Dickinson’s “Natural disasters like earthquakes, localized droughts leading to famines, or epidemic diseases could have acted as catalysts for trouble or have exacerbated an already deteriorating situation”.<sup>51</sup> Dickinson also showed that many sites were abandoned at the

end of the Bronze Age not reoccupied for many centuries. This would be expected when an infectious disease epidemic is active. His abandoned city list included places such as Gla, Messenia and Krisa in the Aegean, besides the well documented abandonment of Hattusa, the Hittite capital in Anatolia.

Guy Middleton's PhD, "Theories of Mycenaean Collapse", favored the idea of infectious disease as a cause of the collapse, so it included a section on "Plagues and epidemics" but stated "The main problem with the plague hypothesis is the lack of positive evidence".<sup>52</sup> It also stated "Much about the plague hypothesis seems attractive in the way it can explain the changes in settlement pattern, material and social cultural and long-term decline in population levels".<sup>53</sup> The plague hypothesis was also good for "explaining the variability of collapse"<sup>54</sup> because "palatial areas may have been more densely settled and thus more seriously affected, while possibly less populous peripheral areas may have been less affected".<sup>55</sup> Once the central palace was adversely affected: "This lack of strong central power and instability seems to fit with the kind of unstable and more mobile society suggested for palatial Greece."<sup>56</sup>

Emeritus Robert Arnott from Oxford University wrote chapter 1 "Disease and the Prehistory of the Aegean" in *Health in Antiquity* edited by Helen King, in which he listed some of the possible diseases from that time which included: thalassemia, malaria, tuberculosis, brucellosis, malnutrition, scurvy, anemia, measles, chickenpox, oral infection, pneumonia, hemolytic disease, enteropathies, cholera, typhoid, dysentery, tetanus, hookworm, mumps, whooping cough and amoebiosis. Note that most diseases listed are infectious diseases. He also gave a possible reason why disease has not been considered as a cause for the end of the Bronze Age because "many such scholars are completely unaware of the social effects of disease and the major consequences that ensued whenever contacts across disease boundaries allowed a new infection to invade a population that lacked any acquired immunity."<sup>57</sup>

Arnott referred to the research of J. Lawrence Angel (also known as the archaeologist "bone man") and Robert Sallares who have found the lethal *falciparum* malaria DNA in ancient skeletons, making malaria a strong infectious disease that possibly contributed to the end of the Bronze Age. He also supported the drought leading onto disease hypothesis stating "If widespread climatic change and drought were mainly responsible for the decline and collapse of the Mycenaean world in the twelfth century BC,

as has been suggested ... then a natural consequence would have been widespread epidemic disease (e.g. cholera and typhoid) brought on by the shortage of clean drinking water".<sup>58</sup> In conclusion, Arnott paints a very bleak picture of life for the ordinary man in ancient times "the harsh reality of a society where life was hard, death and disease were everyday occurrences and the day-to-day ambition of those who lived outside the palaces was simply survival".<sup>59</sup>

Eric Watson-Williams wrote an article about the end of the Bronze Age called "The End of an Epoch" in which he championed bubonic plague as the sole cause for the catastrophe. "What seems so puzzling is the reason why these apparently strong and prosperous kingdoms should disintegrate"<sup>60</sup> he questioned. He cites abandonment of cities, the adoption of the practice of cremation of the dead instead of the usual burial because so many people died, and it was necessary to destroy the decomposing bodies quickly, and the fact that bubonic plague is very deadly killing animals and birds as well as humans, affects large areas, spreads rapidly and lingers for many years as reasons for his choice of bubonic plague. Unlike Panagiotakopulu, he provides no physical evidence, but uses history to compare how things were during later bubonic plague epidemics such as the Plague of Justinian and the Black Death to how things were around 1200 BCE.

Watson-Williams argues that there were four epidemics of the bubonic plague that we know of in ancient times, namely the Hittite Epidemic of 1322 BCE, the Exodus from Egypt in the reign of Merneptah c.1230 BCE, the Plague of the Philistines c.1130 BCE and finally the plague "that which destroyed the army of Sennacherib (701 B.C.)".<sup>61</sup> He also quotes a pestilence that killed 70,000 men in three days during the reign of King David c.1017 BCE that may have been bubonic plague.

Lars Walloe from the University of Oslo had a similar view to that of Watson-Williams when he wrote his article "Was the disruption of the Mycenaean world caused by repeated epidemics of bubonic plague?" He noted the "large movements of population";<sup>62</sup> "The population decreased in successive steps during the first two or three epidemics of plague down to perhaps half or one-third of its pre-plague level";<sup>63</sup> and that there was "a substantial reduction in agricultural production".<sup>64</sup> This led to famine and the abandoning of settlements. He thus concluded that bubonic plague accounted for all of these observations rather than other infectious diseases such as anthrax.

DISEASES THAT MAY HAVE CAUSED THE END  
OF THE BRONZE AGE AND THE END OF THE HITTITE  
EMPIRE

*What Are the Most Likely Diseases That Could Have Helped End  
the Bronze Age and What is the Evidence?*

Any historian trying to find the cause of the end of the Bronze Age and the Hittite Empire must explain: the short time frame of approximately 50 years, when it occurred between 1200–1150 BCE; the mass migrations not only of normal people but also of the “Sea Peoples”; and the fact that so many large cities, such as the Hittite capital Hattusa, were simply abandoned and not destroyed or occupied by raiders or invaders. Disease in the form of infection epidemics provides one plausible explanation; there is nothing like a severe widespread plague to deliver the final fatal blow to an empire or an era.

*Bubonic Plague*

The bubonic plague is caused by the *Yersinia pestis* and is transmitted to man by fleas from small rodents such as rats. It is a very lethal disease killing two out of every three people infected within four days. The usually accepted first outbreak of bubonic plague was the Plague of Justinian in 541. “The first recorded outbreak of bubonic plague was the world’s first great pandemic. Called the Mortalitas Magna (Great Death) or the Plague of Justinian, it began in Arabia ... The pestilence reached Constantinople by the spring of A.D. 542 and lurked around the eastern Mediterranean until the 760s.”<sup>65</sup>

New research however by Mark Achtman has suggested that the bubonic plague began near China c. 600BCE and spread to Europe via Central Asia’s “Silk Road”.

Mark Achtman’s research was published in Nature Genetics in an article titled “*Yersinia pestis* genome sequencing identifies patterns of global phylogenetic diversity”.<sup>66</sup> His team compared seventeen whole genomes of *Yersinia pestis* isolates from various global sources and “conducted phylogenetic analyses on this sequence variation dataset, assigned isolates to populations based on maximum parsimony and, from these results, made inferences regarding historical transmission routes. The phylogenetic analysis suggests that *Yersinia pestis* evolved in or near China and

spread through multiple radiations to Europe, South America, Africa and Southeast Asia, leading to country-specific lineages”.<sup>67</sup>

Mark Achtman BSc, MSc, PhD from the University of California, Berkeley, USA is a Canadian microbiology researcher at the University College, Cork, Ireland where he specializes in the population genetics of bacterial pathogens and microbial phylogeography. Prior to this he was a researcher at the Max-Planck Institute in Berlin, Germany specializing in molecular genetics and infections biology.

But, as shown earlier in this book, Kozloff and Panagiotakopulu argue that bubonic plague, coming from India [? Indus Valley Civilization] could have occurred during the reign of Amenhotep III early in the fourteenth century BCE, that is, predating Achtman’s Chinese suggestion by over 750 years. Thus, if Achtman continued his research he may find that China may have contracted the plague from India, and that India was the primary source of the bubonic plague.

This all leads to the Plague of the Philistines, also known as the Plague of Ashdod, which occurred c.1190 BCE and may have been caused by the bubonic plague. If Egypt had bubonic plague during the reigns of Amenhotep III and his son, Akhenaten (c1370–1350 BCE) then it could have recurred to the north east in southern Canaan fifty years later.

The Philistines lived in south Canaan at the end of the Bronze Age and ruled their five city-states (Pentapolis of Gaza, Ashkelon, Ashdod, Ekron and Gath). They were the Kingdom of Israel’s worst enemy and they fought each other many times. Their origin is obscure though. Some historians, such as Carl Ehrlich,<sup>68</sup> believe they were “Sea Peoples” from either the Aegean or Mycenae in Greece who settled in southern Canaan after being defeated by Pharaoh Ramesses III in c.1190 BCE, while others such as Riemenschneider<sup>69</sup> believe they came from Anatolia as refugees from the crumbling Hittite Empire.

As stated earlier the Plague of the Philistines occurred c.1190 BCE<sup>70</sup> while others think it may have occurred later, either 1141 BCE or in the second half of the eleventh century BCE.<sup>71</sup> But Peter Kuniholm’s Aegean Dendrochronology Project has shown that our current dating scheme for ancient times maybe anywhere up to 150 years out when compared to his tree ring dating scheme. “Long standing assumptions and conventions in other Egyptian and Old World chronology and history will need to be re-examined”<sup>72</sup> he has stated, hence the 1141 BCE stated above could in fact have been about 50 years out making it c.1190 BCE.

According to author Lee Allyn Davis in his book *Natural Disasters*, the Philistine Plague was caused by bubonic plague and began in 1200 BCE after the Philistines captured the Ark of the Covenant (a box that contained ancient Hebrew records such as the Ten Commandments and the First Torah Scroll) from the Israelites.

The first recorded plague is the one which beset the Philistines in 1200 BCE, and which is recorded in the Bible in the Book of Samuel. The Philistines in this year defeated an army of nomadic Hebrews at Ebenezer, captured the sacred Ark of the Covenant and carried it in triumph to Ashdod, a city near the Mediterranean Sea. But their triumph was immediately tainted, according to 1 Samuel 5:9: “the hand of the Lord was against the city with a very great destruction; and he smote the men of the city, both small and great, and they had Emerods (swellings) in their secret parts”.

The description makes it clear that bubonic plague had invaded the army of Philistines, probably from a stricken ship. If it had originated in the Ark of the Covenant as the Bible notes, it would have been mentioned in the Old Testament.

Wherever they took the Ark (of the Covenant), the Philistines took plague too. They moved from Ashdod inland to Gath, then to Ekron. The plague followed them. Terrified, they trundled the Ark of the Covenant into a cart pulled by two milk cows. If the cows took the Ark to the Hebrew border town of Beth-shemesh, they reasoned that the Lord of Israel was responsible for the plague, and had indeed smitten them.

The cows took the Ark into the field of Beth-shemite, Joshua stopping alongside a huge stone. Israel rejoiced, but not for long. In 1 Samuel 6:19, the Bible chronicles the inexorable progress of the plague; “and he smote the men of Beth-shemesh, because they had looked at the Ark of the Lord, even He smote the people fifty thousand and three score and ten men; and the people lamented because the Lord had smitten many of the people with a great slaughter”.<sup>73</sup>

Davis gets his idea of the plague coming from a stricken ship and not the Ark of the Covenant from a book about plague called *Plague an Ancient Disease in the Twentieth Century* by Charles T. Gregg.<sup>74</sup> In it Gregg states that the Plague of the Philistines occurred in the twelfth century BCE and that:

The plague of the Philistines probably invaded the town of Ashdod from a stricken ship rather than with the Ark of the Covenant and then infected the crowds that conveyed the ark to the other afflicted cities. Had the plague begun in Israel there should have been accounts of it in the Old Testament, but Samuel mentions the disease no more.<sup>75</sup>



Others who also think the Plague of the Philistines was bubonic plague include W.J. Simpson and W.W.C. Topley and G.S. Wilson.

Simpson (1905)<sup>76</sup> affirms that the pestilence was bubonic plague, and that the “emerods” were plague buboes, and his assertion has been repeated by later writers. Topley and Wilson (1946),<sup>77</sup> for example, assert that “In the fifth and sixth chapters of the First Book of Samuel there is an unmistakable account of bubonic plague.”<sup>78</sup> Simpson served as a health officer in Calcutta and Hong Kong, and was a member of the Royal Society of Tropical Medicine and Hygiene. He was also an MD from Aberdeen, a PRCP (London), DPH (Cambridge), Professor of Hygiene, Kings College, London and Lecturer in Tropical Hygiene at the London School of Tropical Medicine. In 1905 he published his book *A Treatise on Plague* through Cambridge University Press.

The description of the plague also mentions tumors that could have been buboes or the swollen lymph nodes associated with bubonic plague. Watson-Williams<sup>79</sup> and Walloe<sup>80</sup> also support the theory that bubonic plague caused the Hittite Epidemic of 1322 BCE, the Plague of the Philistines c.1190 BCE and the end of the Bronze Age c.1200 BCE. From its bases in Egypt and Canaan the bubonic plague could have spread across the entire Near East and Eastern Mediterranean region destroying empires and ending the Bronze Age.

Wilson MD, FRCP, DPH Director of Public Health Laboratory Service, England and Wales was a British bacteriologist, a member of the UK Whooping Cough Immunisation Committee in 1954, and wrote the Foreword to Hugh Paul’s book *Control of Communicable Diseases* published in 1953. Topley (1886–1944) was a British bacteriologist who became Fellow of the Royal Society in 1930. Together Wilson and Topley wrote the standard textbook on the subject of Pathology namely *Topley and Wilson’s Principles of Bacteriology and Immunity* in 1946.

### *Dysentery*

In his book on the *Plague of the Philistines*<sup>81</sup> Shrewsbury goes against the conclusions of his fellow British bacteriologists Simpson, and Topley and Wilson and instead endorses the belief of the first century Romano-Jewish historian Titus Flavius Josephus (37–c.100 CE) who stated “categorically that it was dysentery, and he also discriminates the epidemic from the simultaneous plague of mice”.<sup>82</sup> This idea was revealed by W. Whiston who translated the works of Flavius Josephus and had them published in 1793.<sup>83</sup>

John Findlay Drew Shrewsbury (1898–1971) was Professor of Bacteriology at the University of Birmingham from 1937 to 1963. He wrote on the historical aspects of infectious diseases especially about the plague writing *A History of the Bubonic Plague in the British Isles* reprinted in 2005 by Cambridge University Press, *Epidemic Disease and History* in 1947 and *The Plague of the Philistines, and other Medical-Historical Essays* in 1964 for example. Shrewsbury writes:

It is possible that Josephus had access to authentic material that has since been lost; it is certain that he was many centuries nearer the ancient Jewish tradition than we are, and, though it appears to be fashionable in some quarters to decry the value of tradition as an adjunct to history, it is not wise to ignore it. With the support of Josephus, I submit, therefore that the plague of the Philistines was one of the forms of bacillary dysentery, either Shiga or a virulent Flexner dysentery, and that the “emerods” were “piles.”<sup>84</sup>

Note his point that “it is not wise to ignore it”. In other words he is warning us that it is not wise to ignore the ideas of Josephus.

The basis for his findings were the facts that he thought firstly the “secret part” of the body as the only part not visible when naked, that is, the anal area and that “hemerods” were in fact hemorrhoids or piles, which would be made worse with dysentery. This is in contrast to the others who thought the “secret part” was the genital area in general hence the “hemerods” were buboes or the swollen lymph nodes in the groin; because buboes are inflamed lymph nodes and there are no lymph nodes in the anal area.

The communicable diseases that have scourged armies throughout historical times are typhus fever, typhoid fever, and dysentery, and there can be no doubt that the pestilence that afflicted the Philistines first erupted in their army, and was then disseminated by their victorious troops among the civilian population of their cities. Typhus fever and typhoid fever can be dismissed, because neither disease is accompanied by the development of swellings around the anus; but bacillary dysentery is frequently associated, because of the invariable concomitant tenesmus, with the formation of external piles, those rounded protuberances from the anal margins that are at first hot, red and painful, but which later often itch considerably as they resolve. It is commonly stated in medical textbooks that bacillary dysentery in hot climates is more prone to give rise to piles than is the disease in temperate ones. The usual explanation

given is that the anal sphincter is generally more lax in individuals living in hot lands than in those living in temperate regions.<sup>85</sup>

But Shrewsbury gives another reason for his conclusion that the Plague of the Philistines was in fact dysentery and not bubonic plague.

There is still the third clue to be considered; to wit, the fact that the Gethrites, after deliberate consultation, made “seats of skins” for themselves. To those who still opine that the pestilence of the Philistines was bubonic plague, the question may be put: Why should any sane individual make themselves seats of skins as a palliative for bubonic plague? Of what conceivable use would a skin seat be to a person who is collapsed, delirious, and bed-ridden almost from the onset of that disease? If the “emerods” were plague buboes, the action of the Gethrites was utterly nonsensical; but if, as I have argued, they were hemorrhoids, then anyone who has suffered from external piles will agree that the Gethrites showed good sense. The difference in comfort to the sufferer from piles between reclining upon a skin seat and sitting cross-legged upon the ground must be experienced to be appreciated, but I can assure the reader that it is profound.<sup>86</sup>

The significance of the plague cannot be underestimated. Because of this plague the Philistines returned the Ark of the Covenant back to the Israelites to get rid of it, which consequently allowed them to flourish.

Whatever opinion is held about the nature of the pestilence that ravaged the Philistines, the fact that it caused them to return the Ark of the Covenant to the defeated and demoralized Israelites is indisputable. That restoration deprived the Philistines of the inestimable moral advantage that the possession of the Ark gave to them, and at the same time restored to the Israelites the focus upon which all their national activities and aspirations converged. I therefore affirm that this act, because it saved the Israelite society from almost certain extinction, must be ranked as one of the decisive acts in human history, and I draw support for that affirmation from the authoritative pronouncement of Osterley and Robinson (1932): “Yet small and insignificant among the nations of the world as Israel was, without political influence or extended power, it may safely be said that no other people of antiquity holds a place of such profound importance in the history of human thought. It was Israel who gave to the world a religion which has directed the spiritual life of nearly half mankind, and, not only among the Jews themselves, but in the two daughter faiths of Christianity and Islam, has molded the beliefs of men in every continent save central and eastern Asia”.<sup>87</sup>

William Oscar Emil Osterley and T.H. Robinson were historians who wrote the book *A History of Israel* published by Oxford University Press in 1932. The other aspect of this plague is the fact that it occurred in Palestine, which Shrewsbury referred to as the “cock pit”<sup>88</sup>) of the ancient world. According to Osterley and Robinson “Palestine was the commercial, military and political center of the ancient world, and on it focused all the greatest movements of the peoples”<sup>89</sup> because any conqueror had to control it if they wanted free movement from Europe or Asia into Africa or in the reverse. So controlling Palestine was vital because of this movement factor between Europe, Asia and Africa, the same factor that would also have easily spread the plague via the fleeing masses into adjoining regions thus spreading it throughout the Near East during the end of the Bronze Age.

### *Tularemia*

The following hypothesis about Tularemia is included for the sake of completeness, so that no option is left out or eliminated from the list of potential infectious diseases that caused the end of the Near Eastern Bronze Age.

Tularemia, also known as Rabbit Fever, is a bacterial infection caused by *Francisella tularensis*. It is easily spread and is highly virulent making it the perfect infective agent for an epidemic. For these reasons it, along with dysentery (already discussed), the bubonic plague (already discussed), smallpox (to be discussed as the next infective disease), and anthrax (to be discussed later), have been used as infective disease agents for biological warfare.

*Francisella tularensis* infects small mammals such as rabbits, hares and other rodents who can in turn infect humans directly or via their ticks or mosquito or flies. “Humans can get the disease through a bite from an infected tick, horsefly, or mosquito; breathing in infected dirt or plant material (causing pneumonia); direct contact through a break in the skin with an infected animal or its dead body (most often a rabbit, muskrat, beaver, or squirrel) or eating infected rare meat”.<sup>90</sup> So the disease is easily contracted either by direct contact with host rodents, ticks, mosquitoes, flies, ingestion of contaminated food and water or as aerosol particles being inhaled.

Siro Trevisanato, an Italian-Canadian molecular biologist proposed that tularemia was used by the Hittites as a germ warfare agent, caused the

Hittite Plague of 1322 BCE and later still caused the Plague of the Philistines. Trevisanato (1960–) graduated in 1983 with a BA in biology from SUNY Purchase, USA; in 1986 with an MSc in biochemistry from New York Medical College, Valhalla, USA and a PhD in molecular biology from the University Copenhagen, Denmark.

Avaris was a port city in the northeastern region of the Nile Delta. It was the major administrative hub for the Nile Delta during the Hyksos era (Fifteenth Dynasty) and later became the capital of Egypt under the Hyksos. It was occupied from c.1783 to 1550 BCE and according to Trevisanato was the port through which tularemia entered Egypt c.1715 BCE.

Paragraph 170, column 11, lines 12 to 15 of the Hearst Papyrus tells of an infectious disease attributed to “the Asiatics”, that is, people from the Syria—Canaan—Transjordan area also known as the “Canaanite Illness”.<sup>91</sup> It has also been attributed to bubonic plague or typhus.

Austrian archaeologist Manfred Bietak uncovered the ruins of Avaris at Tell el-Dab’a in the Eastern Nile Delta. There he also found unequivocal signs of an epidemic. More precisely, the layer dividing the so-called stratum G from stratum F of Avaris contains a large number of tombs, which are characterized by a hasty job. This fact is the signature of emergency situations such as those existing during a plague. Artefacts in the tombs revealed that they and, thus the epidemic, could be dated to c.1715 BCE.<sup>92</sup>

During the epidemic of 1715 BCE the Hebrew population in Avaris fared a lot better than the local Egyptians because the Egyptians living in the city had no immunity to tularemia while the Hebrews, who were exposed to sheep and other animals, had a natural immunity to tularemia and survived. If the disease had been bubonic plague or typhus then the Hebrews would have died at the same rate as the Egyptians. Trevisanato also thinks that the Hittite Epidemic of 1322 BCE was due to tularemia rather than bubonic plague.

A deadly epidemic, also dubbed the Hittite plague, affected most of the Middle East towards the end of the fourteenth century BCE. The present study determined that its onset was described in the Egyptian royal archives, enabling to date it to the last reigning years of Akhenaten, that is, just before 1335 BCE, and locate the focus to an area northeast of Byblos (present-day Lebanon).

Letter EA 96 states that “there is a pestilence in Simyra”. Anyone from Simyra was barred from entering nearby Byblos, and donkeys were not to be used in caravans because of the pestilence. The measure did not work, as evidenced by letter EA 362 stating the pestilence did reach Byblos, and by letter EA 137 stating the Byblos ruler became chronically ill. The plague spread further south as attested by the ruler of Amurru in present-day southern Lebanon, who referred to his relationship with Byblos, and mentioned he was now sick, and was going to die (EA 95). Still further south, along the coastal trade route from Byblos, coeval letter EA 224 reports Megiddo “is consumed by pestilence”.

The east-west trade road going through Simyra linked the Mediterranean coast to the Euphrates. Reports from 1335 BCE show that east of Simyra in Babylon, an aristocratic woman died from plague (EA 7), and the local ruler was ill (EA 11), consistent with the spread along the trade route. West of Simyra, coeval letter EA 35 from Cyprus stated “the hand of Nergal is in my country”, killing many, in particular individuals linked to copper mining. The attribution of the plague to the Mesopotamian god of pestilence Nergal points to an origin from the east, that is, via Canaanite harbors and indicates that the etiological agent also travelled by ship.<sup>93</sup>

Note that the letters referred to in the above quote are Amarna letters and are quoted from William Moran’s book *The Amarna Letters* published in 1992 by the John Hopkins University Press, USA.

Trevisonato argues that initially the epidemic was confined to the central area of the Near East from Cyprus to Iraq and from Israel to Syria, sparing Egypt and the Neshite or Hittite Empire. Later, after fighting between Egypt and the Hittites at Amka on the Litani River to east of Byblos and Simyra in c.1325 BCE, the tularemia infection spread into Anatolia via the Egyptian prisoners of war to cause the 20-year Hittite Plague. It would have also spread via the various trade routes that went through the Levant.

In c.1320 BCE, Arzawa in western Anatolia attacked the Hittites. Eventually, after a Hittite counterattack, the Hittites laid siege to the capital of Arzawa. During this siege the Hittites left sheep carrying tularemia outside the city walls. The starving inhabitants of the city brought the sheep into their city where they, unbeknown to the city inhabitants, spread the disease among the population. Thus this is the first documented example of biological warfare.

Trevisonato argues why he thinks the epidemic was caused by tularemia:

The reconstruction of the dynamics of the epidemic helps identifying the etiological agent. A disease lasting 35–40 years, infecting humans and animals, causing fever, disabilities, and death, spreading via rodents aboard ships as well as donkeys, points to *Francisella tularensis*, the etiological agent of tularemia. This disease can linger for a long time, and its longevity is incompatible with shorter-lived epidemics such as from bubonic plague, which for instance hit Europe around 1347–1349, and in 1629–1634. Furthermore, the description in Neshite records, e.g. knees, debilitation, and sensation of internal burning, is also coherent with tularemia. Moreover, tularemia also fits the onset of the infection, as it infects caravans stopping for rest, turning them into carriers for the etiological agent. The aforementioned trading route between the Mediterranean Sea and the Euphrates would have had such contact points allowing for the spread of the pathogen.<sup>94</sup>

Trevisonato further believes that the Plague of the Philistines was also due to tularemia, which has Canaan, the setting for the Plague of the Philistines, as a natural reservoir as shown above. He does not believe it was due to bubonic plague or dysentery and puts forward a strong argument:

An etiological agent for the Philistine plague. The biblical data appear to center around the box as a vehicle for the disease, as well as the rodents that appear shortly thereafter, and are depicted in the “settlement” paid in gold. The Hebrew word *akbbar* for the rodents fails to distinguish between mice and rats. Rats would have carried *Y. pestis* but bubonic plague fails to adequately explain the epidemic. Mice are a better option; they can carry diseases, and fit the other data relative to the historical text, i.e. box, idol, and settlement payment.

The gold-plated wooden box measured  $2.5 \times 1.5 \times 1.5$  cubits (Ex. 25.10-22; Ex. 37,5-10), that is,  $1.1 \times 0.7 \times 0.7$ m, giving a volume of roughly 500 l, offering a nest to mice but not rats. The former animals average 20g and are small enough to enter the box through a small aperture possibly hidden by the gold covering. The latter animals average 300g requiring a wider aperture and more internal space. Mice nesting in the box would have explored their new habitat upon each transfer of the box, thus offering an explanation for the box transmitting the disease.

Mice also explain the otherwise odd detail of a small Philistine idol falling on the floor. Once the box was hosted in the Philistine temple, the animals exiting the box from the same aperture, would have tipped over the statuette, eventually breaking the extremities after repeated falls (1Sa.5.2-5).

The five replicas in gold of rodents and tumors to settle the dispute with the Hebrews (1Sa.6.3-5) also favor mice over rats. Given the specific gravity of gold, just over 19 kg/l, a gold mouse would be shy of 400 g, while a rat would be shy of 6 kg. Considering 10–20 g tumors, the Philistines were paying roughly 3–4 kg of gold in total. Rat-like tumors would have resulted in 31–32 kg of gold, where the tumors would have only contributed marginally (additional 3–6%) to the gold already provided by the rats, raising the question of their *raison d'être*.

Linking mice to the box and to the disease singles out tularemia as the disease portrayed by the biblical text; mice are known to carry *Francisella tularensis*, the etiological agent for tularemia. Moreover, the text calls for a disease that originated from animals, can be communicated, can form tumors, and is deadly.<sup>95</sup>

So now there are arguments for the three virulent infections namely bubonic plague, dysentery and now tularemia, being present in the Near East at the end of the Bronze Age.

### *Smallpox*

Smallpox or variole is a virulent infection caused by a virus. It was first called smallpox in Europe in the late fifteenth century to distinguish it from the “great pox” or syphilis. Thought to have originated in north eastern Africa 10,000 BCE, smallpox then spread to Egypt and from there onto India.<sup>96</sup>

Ramesses V is the fourth pharaoh of the Twentieth Dynasty of Egypt and he died c.1157 BCE<sup>97</sup> most likely from smallpox. The well-preserved mummy of Ramesses V shows classical smallpox lesions on the face, neck and shoulders as verified by Donald R. Hopkins in 1979.<sup>98</sup> This period was a time of expansion of the Egyptian Empire, so cases of smallpox could have been imported into Egypt because of this expansion into new territories and war. If the pharaoh, who would have been protected from all harm, finally succumbed to smallpox; how long had it been ravaging the general population of Egypt and how far had it spread in the Near East?

Sir Marc Armand Ruffer in 1910 described a smallpox like rash on a mummy from the same period (Twentieth Dynasty) as Ramesses V,<sup>99</sup> thus giving further primary physical evidence of the existence of smallpox in the Near East at the time of its ending between 1200 and 1150 BCE. Sir Marc



Armand Ruffer (1859–1917) was an Anglo-French pathologist who pioneered paleopathology. In 1882 he graduated from Oxford with a BA, then in 1887 gained his MBChB from University College in London followed by his MD in 1889. In 1916 he was knighted for his services to bacteriology and hygiene and for his services to the Red Cross Organization.

Normally a pharaoh is mummified and buried precisely 70 days into the reign of his successor<sup>100</sup> but Ramesses V was buried two years after his death—why? Hopkins suggests three possible reasons for this. First the body may have deteriorated due to the infection hence it needed prolonged mummification. Second the embalmers feared being infected by the smallpox. Finally there may have been a shortage of embalmers because they too had been killed by the smallpox epidemic. There may have also been a shortage of stone masons and stone cutters as well, because Ramesses VI was also buried in the tomb of Ramesses V, that is, two pharaohs in the one tomb, which is not the usual practice.

Tom Slattery has degrees in East Asian Studies from the University of California, Berkeley and in English from Central Washington University. In his book *The Tragic End of the Bronze Age. A Virus makes History*<sup>101</sup> Slattery argues that smallpox may have killed Ramesses V and started the end of the Bronze Age. He also argues that as people died with smallpox there were not enough men to mine tin that was vital in bronze production, hence the Bronze Age ended because less bronze was able to be made. Slattery also thinks that the Hittite Plague of 1322 BCE was due to smallpox.

### *Tuberculosis*

The evidence for the existence of tuberculosis during the Bronze Age comes again from Sir Marc Ruffer and his examination of Egyptian mummies. In his book *Studies in the Paleo pathology of Egypt* he identifies the typical spinal lesions of Pott's disease as shown in Plate IX, figures 14 and 15.<sup>102</sup> Modern science has also identified the DNA of *Mycobacterium tuberculosis* in the spine of Egyptian mummies,<sup>103</sup> thus providing primary physical evidence for the existence of tuberculosis in the Near East in the late Bronze Age. In the crowded living conditions in cities with malnutrition and poverty, tuberculosis would have had the perfect breeding conditions in which to flourish and devastate the local population in the late Bronze Age with its high mortality rate.

*Influenza*

Influenza in an unprotected population had the potential to be catastrophic but there is no good evidence to support this theory. We only have its potential as a cause of an epidemic.

*Poliomyelitis*

Poliomyelitis had the potential to be devastating and Egyptian paintings confirm its existence in the late Bronze Age, so it is a definite possible cause of an epidemic.

*Anthrax*

Anthrax is a bacterial infection caused by the bacillus anthracis and is usually fatal in both humans and animals. Because it is so lethal it is used as one of the agents in biological or germ warfare today. In the late Bronze Age with no vaccine or antibiotics an epidemic would be catastrophic.

The endospores of the bacterium anthracis can survive for decades or even centuries and when they are inhaled, ingested or come in contact with the skin they can cause the disease in animals or humans. Herbivorous animals usually ingest the spores whilst grazing and carnivores usually ingest the spores when eating an infected animal. Humans usually contract the disease by inhalation of spores, direct contact of spores with the skin or consumption of the flesh of an infected animal.

One of the Ten Plagues suffered by Egypt, as described in the Bible, could have been anthrax with the description of the typical anthrax sores on the animals, which confirms that anthrax existed in the Near East in the Bronze Age; hence this is another possible cause of an epidemic.

*Measles*

Measles in a vulnerable population has the potential to cause a lethal epidemic, but unfortunately there is no good evidence or records to show it occurred. We only have its potential as a cause of an epidemic.

*Malaria*

Malaria has been infecting humans “for the entire history of the species”<sup>104</sup> and existed in the Near East from Anatolia through the Levant and into

the Nile in Egypt in the late Bronze Age, as it still does today. So it had the constant potential to cause death in humans, especially the virulent *Falciparum* strain during the end of the Bronze Age era.

### *Typhus*

Typhus is a zoonosis that is transferred to humans via lice. It was common among groups of people who lived very closely together such as soldiers in barracks, sailors in ships, prisoners in gaols and refugees in camps; hence it was known variously as “barrack fever”, “ship fever”, “gaol fever” or “camp fever”.

Was the epidemic that the Egyptian prisoners of war took into the Hittite Empire, that caused the Hittite Epidemic of 1322 BCE, really typhus “camp fever” and not smallpox or bubonic plague? Also, as discussed earlier—typhus may have caused the Plague of the Philistines.

In summary, what was needed was an epidemic or several epidemics that had the ability to be lethal, widespread and able to continue for long periods of time or recur frequently; this would be able to change the course of history by destroying empires such as the Mycenaean and Hittite Empires and ending the Bronze Age. Because the end of the Bronze Age is approximately 3,200 years ago, then the virgin population factor has to be taken into consideration as some of the epidemics, such as influenza and measles, may have been the first appearance of these infections in history, hence they would be a lot more lethal than they are today in the same area, the Near East.

Of the diseases discussed above, there is evidence that bubonic plague, smallpox and tularemia fit these criteria and there is evidence of their existence in the Near East at the time. Dysentery and typhus would be more localized and shorter lived, but still very lethal in its time and place.

Poliomyelitis and tuberculosis would be too slow to kill and spread over a wide area but potentially lethal locally. Anthrax and malaria are also possibilities. There is no good evidence or records to support the existence of influenza and measles. They may well have occurred and been lethal, but if they did occur they would have been seasonal and relatively short-lived epidemics.

This is in agreement with Itamar Singer’s understanding who said “plagues are already attested in Anatolia in the Old Assyrian Colony period (Cecen 1995), and are often mentioned in Late Bronze Age Syrian documents (Klengel 1999b)”.<sup>105</sup>

So it is possible that diseases could have contributed to the end of the Hittite Empire and the end of the Bronze Age in a major way. Because of the timeframe of about 50 years from c.1200–1150 BCE there was plenty of time to have several major lethal epidemics such as bubonic plague, smallpox and tularemia occur on a widespread scale, supported by more local epidemics such as dysentery, poliomyelitis, tuberculosis, measles, influenza, anthrax and malaria. In a time of poor hygiene, no antibiotics and no vaccines these infections (five of which are so virulent that they are still used as germ warfare agents today, namely bubonic plague, smallpox, tuberculosis, anthrax and dysentery) had the potential to devastate the Near East and should be factored in as potential cofactors in the future by historians. Any future discussions about the end of the Hittite Empire and end of the Bronze Age should be considered as incomplete if disease is not considered and included.

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