# News & views

Archaeology

## Signs of climate crisis as an ancient empire unravelled

Müge Durusu-Tanrıöver

An assessment of juniper tree-ring samples from central Turkey, together with other types of dating analysis, demonstrate that a devastating drought in 1198–1196 BC contributed to the end of the Hittite empire. See p.719

In around 1300 BC, the eastern Mediterranean region was dominated by the strong empires and kingdoms of the Hittites, Assyrians, Egyptians and Mycenaeans, whose written records give the impression of a thriving and interconnected world. Fast forward, and the same states were in serious trouble by 1170 BC. On page 719, Manning *et al.*[1] present evidence that a severe drought occurred in central Turkey during this period, and suggest that a climate crisis was a key player in the Hittite empire's demise.

By 1170 BC, the Hittite and Mycenaean political systems had dissolved, and Assyria and Egypt had contracted to their core regions. This episode marks the end of one historical period in ancient western Asia (the Bronze Age, around 3000–1180 BC) and the onset of another (the Iron Age, which spanned 1180–330 BC).

The cause of the havoc wreaked at the end of the Bronze Age has been an issue of intense scholarly debate, with suggested culprits including changes in metal-working and warfare technologies, large-scale migrations, invasions of a mysterious maritime coalition called Sea Peoples, inter-state warfare, climate change, famine and epidemics, either individually or in groups. Researchers have started to entertain the idea of a 'perfect storm' — that all these events coexisted to create a system-shattering episode[2].

Even so, many questions remain about the initial trigger. Did climate change cause famine, and consequently warfare? Did famine and drought lead to epidemics and displaced communities, or were migrations the drivers of diseases? The temporal resolution of archaeological data for the end of the Bronze Age is not high enough to pinpoint such events, leaving us unclear about their exact sequence, or even their occurrence.

Manning and colleagues' work makes a crucial contribution to this dilemma by not only proving the presence of a major climate event, but also identifying its exact dates, a feat not previously possible. The authors analysed juniper (*Juniperus excelsa* and *Juniperus foetidissima*) timbers excavated from the ancient site of Gordion in central Turkey and studied two characteristics related to water.

First, because less water usually means less growth for trees, narrower tree rings point to drier years. Second, investigating tree samples using a method called carbon-13 stable-isotope analysis offers a way to identify drier episodes through higher-than-normal values of $\delta^{13}C$ (a measure of the relative abundance of $^{13}C$ to $^{12}C$ isotopes) present in the samples. The authors also examined samples for structural changes that take place in extreme drought at the cellular level. The correlation of the results from these kinds of data and their juxtaposition with the continuous annual historical sequence of Gordion tree rings between approximately 1775 BC and 748 BC enabled Manning *et al.* to date the episodes of climate change to a high level of resolution.

The authors' results point to drier-than-usual conditions between the thirteenth and tenth centuries BC, and an extreme three-year drought during 1198–1196 BC. These dates correspond to the tumultuous period recorded at the end of the Bronze Age, and relate directly to the Hittite empire.

Between approximately 1650 and 1180 BC, the Hittites controlled much of what is now modern Turkey and Syria, whereas the central plateau of the Anatolian peninsula (on which most of modern Turkey is located) always remained their core territory, including their capital city at Hattusa (located near the modern town of Boğazkale). The three-year drought identified by the authors might have been one of the key reasons, if not the most important one, for the final dissolution of Hittite political power.

As the authors point out, central Anatolia is an arid, drought-prone region. Communities living in such landscapes develop coping mechanisms for the years with suboptimal rainfall, as evidenced by the massive grain silos

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**Figure 1 | Inscription from Hattusa, Turkey, capital city of the Hittite empire.** The inscription shown details military successes of King Suppiluliuma. It is located in a complex that includes the Eastern Ponds — a major water reservoir and ritual site. Manning *et al.*[1] provide evidence of a prolonged drought during 1198–1196 BC that might have contributed to the empire's fall and the abandonment of Hattusa.

that were a fixture of central Hittite cities and construction of large-scale water infrastructure projects (Fig. 1), such as dams, that gained momentum during the thirteenth century BC.

What is uncommon, however, is a drought that lasts for more than two consecutive years, and which Manning *et al*. suggest is a serious enough event to create a tipping point in communities' efforts at adaptation and resilience. Although rightfully refraining from suggesting a direct causal relationship between this climate extreme and a sudden Hittite collapse, the authors highlight the 1198–1196 BC drought as being a key catalyst that might have caused the empire first to tap heavily into its landscapes for survival, inflicting long-lasting damage on its ecosystems, and ultimately to abandon its central cities, including Hattusa.

One of the many puzzles of Hittite studies is the abandonment of Hattusa during the final decades of the Hittite empire. This seems to have been meticulously planned, because all official buildings were emptied of their portable valuables, suggesting that the royal family moved to another city[3]. In the absence of archaeological evidence for the sacking of the city through warfare or conquest, the reasons for Hattusa's abandonment have been debated, with changes in climate and resulting droughts and famines considered among the candidates. Speculation could go only as far as a general correlation between favourable climatic conditions during the formation of the Hittite empire and adverse ones for its final centuries[4].

Manning and colleagues' study is groundbreaking because it finally gives us a tangible clue to why Hattusa was abandoned. Future research might discover whether the extreme climate event of 1198–1196 BC was confined to central Anatolia or was a larger eastern Mediterranean phenomenon that can offer insight beyond the case of the Hittites.

Now that we know a major climate event might have tipped the Hittite empire beyond its point of no return, there are more questions to ask about climate change, its impact on states and society and, most crucially, what can be learnt from the past during our current climate crisis. The Hittite case makes one point abundantly clear: extended political and economic systems are especially fragile in the face of extreme climate events. When such systems collapse, large urban centres become unsustainable, begging the question of whether they were ever truly viable. Through urban decline, communities get another chance to live in smaller units, attempting to coexist with their landscapes and to draw more sustainably from a larger diversity of resources that are available in smaller quantities.

Archaeological perspectives on the past should make us think about possible alternative paths for human settlement, without romanticizing an idyllic rural life or demonizing all urban conglomerates. Such exploration would not be new. The rapidly expanding and unsanitary urban environments of the Industrial Revolution and its aftermath triggered multiple responses, ranging from partially built models, such as English urban planner Ebenezer Howard's garden cities, to utopias such as US architect Frank Lloyd Wright's Broadacre City. Howard called for a marriage between town and country through small cities surrounded by green belts, agricultural zones and sustainable industry, whereas Lloyd Wright advocated a model of no absentee or corporate ownership, in which production would be centred on individual homesteads.

Although sustainable urban–rural systems have been discussed for centuries, these options have been superseded by the ever-expanding metropolises that trick us into imagining a sense of stability there. Now is the time not only to dream creatively but also to generate cities that have lighter footprints, dispersed settlements and a balanced urban–rural divide.

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**The author declares no competing interests.**
**This article was published online on 8 February 2023.**

Evolution

# Tropical biodiversity linked to polar climate

**Moriaki Yasuhara & Curtis A. Deutsch**

The rise in species diversity towards the tropics is a striking and unexplained global phenomenon. Ocean microfossil evidence suggests that this pattern arose as a result of ancient climate cooling and polar-climate dynamics. **See p.708 & p.713**

The increase in the number of plant and animal species as one moves towards the Equator from higher latitudes is one of the most notable and consistent patterns on land and in the sea. Although the phenomenon has been known since the nineteenth century[1,2], the reasons for this latitudinal diversity gradient (LDG) are not fully understood[3]. The most commonly implicated suspect is an even more glaring and robust latitude-dependent pattern, namely, the rise in temperature from the poles to the Equator. The appeal of temperature-based explanations is bolstered by the role of temperature in innumerable biological processes. But decades of research have not closed the gap between correlation and causation, leaving biodiversity and climate dynamics as largely separate fields of study. Fenton *et al*.[4] (page 708) and Woodhouse *et al*.[5] (page 713) now join some of the missing dots.

A key difficulty in understanding LDG dynamics is that we must rely on nature's own uncontrolled experiments conducted through Earth's history. These produce spectacularly different states of the system, but rarely provide more than a fragmentary record of the data that would be needed to reveal the causes and consequences. However, new tools and approaches, including massive data compilations and Earth-system models, are filling this gap. As Fenton *et al*. and Woodhouse *et al*. report, a new database (called Triton) of ocean fossils spanning the past 40 million years provides a tantalizing picture of how climate has altered the LDG.

The most abundant data for detecting changes to the LDG come from an unlikely source — microscopic fossils of shell-forming ocean plankton called foraminifera. These fossils are ubiquitous in marine sediments, and their species classifications (taxonomy) are well established. Evidence of the distributions of foraminifera over space and time has been compiled in the Triton database, which, as the authors report, enables the detection of changes in the LDG for the past tens of millions of years. Because planktonic foraminiferal diversity is correlated with overall biological diversity[6], this work might shed light on the mechanisms that underlie the LDG for other groups of organism, too.

Biodiversity patterns reconstructed by the authors from Triton's foraminifera data