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Ancient art fills in Egypt's ecological history

Mammal populations shrank during three abrupt climate shifts over the past 6,000 years.

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Charles Edwin Wilbour Fund, Brooklyn Museum

Ancient Egyptian artefacts, like this elaborately carved ivory knife handle from 3300-3100 BCE, helped scientists determine how mammal populations in Egypt have changed over time.

Ancient Egyptian rock inscriptions and carvings on pharaonic tombs chronicle hartebeest and oryx — horned beasts that thrived in the region more than 6,000 years ago. Researchers have now shown that those mammal populations became unstable in concert with significant shifts in Egypt's climate.

The finding is based on a fresh interpretation of an archaeological and palaeontological record of ancient Egyptian mammals pieced together more than a decade ago by the zoologist Dale Osborn[1]. Thirty-eight large-bodied mammals existed in Egypt roughly six millennia ago, compared to just eight species today.

“There are interesting stories buried in the data — at the congruence of the artistic and written record,” says Justin Yeakel, an ecologist at Simon Fraser University in Vancouver, British Columbia, who presented the research this week at the annual meeting of the Ecological Society of America in Minneapolis, Minnesota. For example, the philosopher Aristotle said 2,300 years ago that lions were present, though rare, in Greece; shortly thereafter, the beasts appeared in the local art record for the last time, Yeakel says.

Overlaying records of climate and species occurrences over time, his team found that three dramatic declines in Egypt's ratio of predators to prey coincided with abrupt climate shifts to more arid conditions. The timing of these aridification events also corresponds to major shifts in human populations at the end of the African Humid Period, about 5,500 years ago; during the Akkadian collapse, about 4,140 years ago in what is now Iraq; and about 3,100 years ago, when the Ugaritic civilization collapsed in what is now Syria.

Simulating stability

Once they found the climate correlation, Yeakel and Mathias Pires, an ecological modeller from the University of Sao Paolo in Brazil, examined the consequences of the ancient extinctions on food-web stability. The researchers adapted a method for modelling food-web interactions with limited data[2]. They simulated millions of potential predator–prey interactions using data about species' body sizes. Tests using data from modern Serengeti food webs suggest the model correctly predicts 70% of predator-prey interactions.

Normally, as food webs get smaller, they become more stable, says Yeakel. But his simulations showed that the proportion of stable food webs in Egypt declined over time, with the largest drop in stability occurring over the past 200 years.

“Food webs are giant messy networks,” says Carl Boettiger, a computational ecologist at University of California, Santa Cruz, who was not involved with the work. “This approach is a powerful way to infer the stability of the food web without knowing specifically who eats who, much less the whole network structure,” he adds.

Yeakel and his colleagues confirmed that the extinction patterns in Egypt cannot be explained by random events. They also found that the presence or absence of any one species did not seem to have much impact on a food web — in sharp contrast to conditions today in many landscapes, possibly owing to rapid changes caused by human encroachment.

“We’ve lost redundancy in ecosystems,” Yeakel says, “which is why the absence of any one species can alter the stability of the system.”

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References

1. Osborn D. J. "Mammals of Ancient Egypt" (1998).
2. Gross, T., Rudolf, L., Levin, S. A. & Dieckmann, U. *Science* **325**, 747–750 (2009).