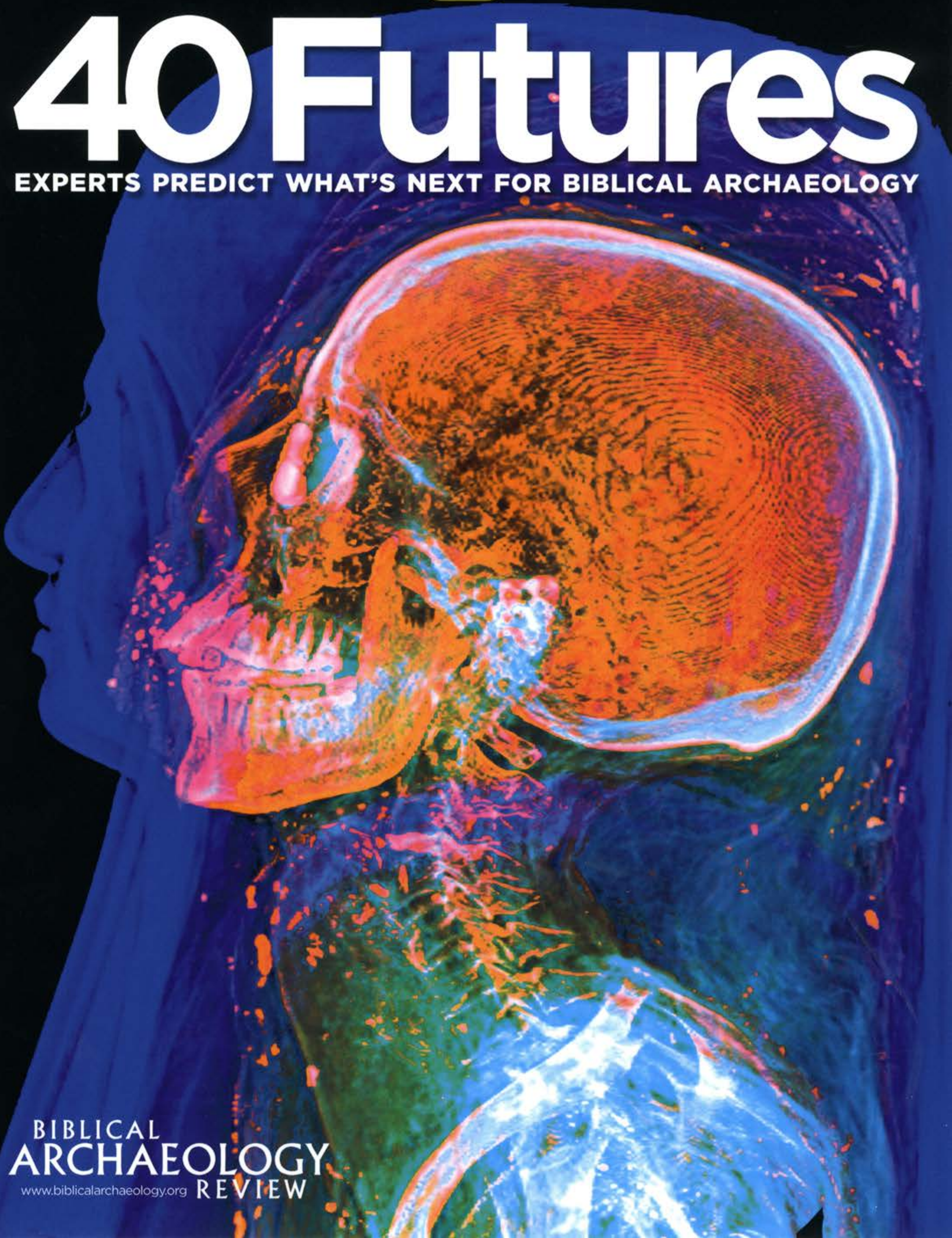
DIGGING DEEPER

40 Futures

EXPERTS PREDICT WHAT'S NEXT FOR BIBLICAL ARCHAEOLOGY



BIBLICAL ARCHAEOLOGY REVIEW
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After 40 years of publishing about Biblical Archaeology past and present, the Biblical Archaeology Society is celebrating by looking forward. So for this collection we asked 40 prominent scholars from every specialized field and with multiple lifetimes of achievements for their predictions. The results range from Science to Science fiction; from Martians to a world of massive data; from convictions that change will revolutionize archaeology—or be of little consequence. This eclectic collection has something to excite the mind and inspire the imagination of every reader.

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4

TRENDING TOWARDS SCIENCE

From the humanities to the social sciences, Michael Eisenberg argues archaeology will end up in the natural sciences

THE LAST 20 years have brought several radical changes in the field of archaeology, which will be significant for forecasting the next four decades. The "hard core" archaeologist will become a rare breed.

Archaeology as a discipline naturally developed as part of the humanities. In time, it has shifted towards the social sciences and nowadays it is trying to relocate to the natural sciences. It is not merely a change in the tools of the discipline, but an overall change in perspective. The shift of emphasis, while it has contributed many positive aspects, has caused a neglect of the historical narratives in archaeological fieldwork. The number of large-scale field expeditions has been reduced, as well as the number of archaeologists working on the Biblical and Classical periods—though this trend might be turning around.

Within 40 years, archaeologists will be more like forensic scientists than historians.

Archaeology's new set of rules—many adopted from the natural sciences—has forced scholars to aim for publication in peer-reviewed journals over the publication of thick volumes of excavation results. The natural sciences, which at one time were tools for archaeology, began to dominate archaeology. Distinguished archaeological and historical journals became second-rate, in favor of leading science journals. This forced many archaeologists to direct their research and articles towards the science journals.

Humanities, including archaeology, have suffered over the last two decades from continually low popularity. As prehistoric archaeology unofficially became a part of the natural sciences, its "younger siblings" Biblical and Classical archaeology lost the interest they held for so many years. Classical archaeology lost some of its worldwide popularity, while Biblical archaeology lost its leading position within Israeli archaeology.

This is not as negative as it might sound. It forced the two fields to reinvent themselves. Now wide regional multidisciplinary research, clear research questions and the adaptation of tools taken mainly from the natural sciences will become the norm in these fields.

This recent shift created some odd anomalies in Israeli archaeology. Some of the humanities specialties were virtually gone and some from the natural sciences that were—up to a decade and half ago—totally absent became overpopulated. The rising demand will force the market to produce fresh specialties, like numismatics and physical anthropology.

As part of this new disinterest, funding for large-scale archaeological excavations has been reduced. In the next decades, the excavation itself will be considered the "archaeologist's lab," which will gain some funding. Nevertheless, conducting an academic, multiseason, large-scale expedition will be almost impossible without private financing. The Israel Antiquities Authority (IAA), the Israel Nature and Parks Authority or other governmental agencies will not provide assistance in the near future, therefore patrons of archaeology are—and will be—crucial for funding field archaeology.

Within two decades, the head archaeologist will function like an Admiral commanding a wide variety of experts. Real-time sensing, direct use of Graphical Information Systems (GIS), photogrammetry and the full digitization of fieldwork will be standard tools for an archaeologist. The use of virtual reality as an analytical tool during the postdig process will also become a basic tool. The romantic anachronism of drawing sherds and artifacts will cease. Full, accurate and efficient digitization and documentation will become part of the archaeologist's work within the next few decades.

Within 40 years, archaeologists will be more like forensic scientists than historians. Some of the human narrative derived from the ancient debris will be lost, while new methods and tools of research will allow a better understanding of artifacts, environment and archaeogeological processes.

Michael Eisenberg is a Senior Researcher at the Zinman Institute of Archaeology and a Senior Lecturer in the Department of Archaeology at the University of Haifa, Israel. He is also the Director of the Hippos-Sussita Excavations Project.

Geographic Information system (GIS) is a general term that can describe any information system that captures, stores, manipulates, analyzes, shares and displays all types of spatial and geographical data.

Photogrammetry is the use of photography to take measurements in surveying or mapping to create a map, drawing or 3D model. Photogrammetry can be used to determine the exact position of an object, artifact or building.

Petrography is the detailed description of the mineral composition (i.e., what minerals are combined to make the clay) of pottery.

6

SMALL THINGS FORGOTTEN

Ayelet Gilboa's excavation future is all about getting down to the details, from the very small finds to the obscure scientific specialty

SINCE TO A large extent the future is here already, it is easy to chart Near Eastern archaeological developments in the last decades that will probably accelerate in the near future. Regarding others, however, we may well witness a shift of the pendulum. Large-scale and prolonged excavations in our region are becoming more and more difficult to implement because of the ever-growing costs of excavation and publication coupled with the ever-increasing demands regarding the detail and comprehensiveness of site reports.

These circumstances, first, dictate and will continue to dictate more and more collaboration among archaeologists and between them and students. This means that the days of the methodological and interpretative tyranny of the single (usually male) director are (nearly) over. The entire process—from site selection to interpretation to publication—will become (occasionally perhaps unwillingly) more collaborative, negotiated and multivocal in a true post-processual spirit. This is a blessing.

This trend will be complemented by the inevitable shift to e-publication of site reports, not merely as digital versions of traditional reports, but as truly interactive hypertexts. This, among other things, will enable much easier and better critiques of the reports and of the excavators' interpretations. Also they will facilitate alternative reconstructions of the data. This too will force excavators/analysts to offer more rigorous, explicit (and time- and money-consuming) presentations of excavation results.

The last decade has seen a revolution in the application of "sciences" to Near Eastern archaeology, arguably the most influential being the application of various high-tech manipulations to the recording, archiving, retrieval and visualization of data. This trend will undoubtedly continue; it is indeed absolutely essential, but in the near future we will all have to assess soberly whether it also brought about a leap in our cultural insights. The same is true regarding the rapidly spreading and diversifying analyses of sediments as part and parcel of the archaeological record of historical sites—a fascinating arena.

These developments, and other fast-developing archaeological sciences (such as zooarchaeology) also mean that more money is available and more students directed to research in these fields—at the expense of the more traditional and humanistic facets of our discipline. Here I foresee a change; no matter how technically advanced our excavations may become, there is no replacing the proficient field archaeologist. No technology will replace accurate and skilled excavation and stratigraphical observations. There is no replacing painstaking, comprehensive ceramic analyses—even if they are the main impediment to publishing site reports quickly.

With the scope of excavations reduced, I also see more in-depth studies in two directions: "household archaeology" and stylistic and analytical studies of artifacts, such as metals, ceramics and various "small things forgotten," like beads. These will certainly entail advances in the application of mineralogy, chemistry and other sciences to the analysis of artifacts.

On the other hand, if we wish to generate new archaeological information that requires very large exposures (such as city plans) some of us will have to decide to do just that. However, archaeological excavation, as we all know, is a zero-sum game; every bit of information is gained at the expense of another that is lost forever. So excavating "big and fast" stands against all current professional norms but from a broader perspective, will need to be reconsidered.

So the main challenge we, as excavators, researchers and teachers, on the disciplinary, institutional and even national levels, face in the next decade is to find the delicate balance between the humanistic and scientific aspects of our profession and between the different sorts of archaeological information we seek to generate. In these respects, and notwithstanding the fact that both my excavation at Tel Dor (Co-directed with Professor Ilan Sharon) and my research have benefited immensely from collaborations with colleagues in the archaeological and other sciences, Kent Flannery's Old Timer in his eternal *The Golden Marshalltown* (1982) still strikes in me a very sympathetic cord.

Ayelet Gilboa is a Lecturer of Archaeology at the Zinman Institute of Archaeology at the University of Haifa and a Director of the Tel Dor excavations.

Hypertexts are texts that link to other information, allowing a reader to jump to different, relevant content.

Household archaeology focuses on the study of everyday life of domestic activities and facilities—the social (families, domestic groups and co-habitations), material (dwellings and structures) and behavioral aspects (activities households perform).

27

DIAGNOSING ANCIENT DNA

Decoding ancient DNA with new new technologies, Guy Bar Oz and Lior Weissbrod foretell that even the smallest fragments will be analyzed for information

THE FIELD OF archaeozoology, or zooarchaeology, developed at a meteoric pace since the 1970s to become one of the most flourishing subdisciplines of archaeology today. One reason for this burst of growth is that archaeozoology, which deals with the study of animal remains from archaeological sites, offers a remarkably versatile tool for investigating the evolution of human economies from prehistoric to near-modern times. Over the last 40 years, the quantity and quality of different types of information retrieved from archaezooological remains have continued to grow through the application of increasingly sophisticated approach combinations from biology and anthropology. The study of ancient DNA, which meshes information on the cultural context, chronology and geographic setting of animal remains with molecular data, is currently among the most promising of such bio-archaeological merges. Archaeozoology has thus morphed into a leading interdisciplinary scientific field.

The coming decades will allow researchers to unlock and decode fully the banks of information which presently remain hidden in ancient animal bones and teeth.

The way forward was initially paved by founding figures such as Joachim Boessneck, Sandor Bökönyi, Juliet Clutton-Brock, Angela von-den Driesch, Pierre Ducos, Brian Hesse, Richard Meadow, Stanley J. Olsen, Eitan Tchernov, Hans-Peter Uerpmann and Paula Wapnish, who were responsible for establishing archaeozoology as a formal scientific discipline in the Near East. These pioneering scientists harnessed the basic tools of biology such as morphometry, allometry and ecological and anthropological theory to address in a systematic fashion fundamental questions in cultural evolution. These include the domestication of animals and the role that early agricultural economies played in the growth of modern state societies and urban civilizations. Through these initial steps, the retrieval of animal remains in archaeological fieldwork has become standard practice, and archaeozoologists have become equal partners in designing and implementing field projects.

From our understanding of current trends within the field, we project that scholars marshalling both the interpretation of cultural contexts and techniques and analyses in the biological sciences will lead future bio-archaeological field projects. The distinguishing characteristic of such bio-archaeologically oriented fieldwork is its targeted approach aimed at retrieving specific data and addressing specific questions in cultural evolution at the intersection of anthropology and biology.

Current practice is largely based in painstaking laboratory analysis involving conventional observation and measurement of fragments of ancient bones and teeth. Archaeozoologists routinely reconstruct the profiles of animals from ancient skeletal fragments. They begin by identifying the species to which the fragments belonged. Further observations reveal the age of the animal at the time of death, and pathologies reflect the impact of disease or injury accrued throughout the animal's life. Finally, analysts consider how the environment, various predators or humans modified the remains between the time of death and discovery. Distinguishing human-made modifications in skeletal remains is necessary, as this information provides direct evidence on butchery and cooking practices in the daily lives of ancient societies.

The realization that food has been a driving

Guy Bar Oz is a Professor of Archaeology at the Zinman Institute of Archaeology at the University of Haifa. His research focuses on the analysis of animal bone remains from prehistoric and historic sites from Israel and the Caucasus.

Lior Weissbrod is a Research Associate at the Zinman Institute of Archaeology at the University of Haifa. His research focuses on the analysis of microvertebrate remains from prehistoric and historical sites in Israel. Currently Weissbrod conducts microfaunal research for the Hippos-Sussita Excavation Project.

Morphometry is the analysis of form and shape (length, width, mass, ratio, angle and area) of landforms, living organisms and other objects. This information can then be used to compare remains between species, landforms from different geographic areas, or artifacts such as ceramic vessels or buildings.

Allometry describes the morphological relationship between the size of an organism and its shape, anatomy, physiology and behavior. Allometry can be used to study individuals within a species and to make comparisons between species.

Phylogeography is the study of which historical processes—such as continental drift, formation or movement of bodies of water and climate change—may have controlled the geographic distribution of species.

force in the evolution of culture has opened the way for researchers over the last four decades to deal with a whole new set of questions regarding the impact of food on technological innovation, the internal organization of societies and our own biology. Considering the tremendous buildup of knowledge and level of understanding having been achieved until now, we anticipate that the next breakthrough will be when the production of archaeozoological data becomes a joint global effort. We envision in the future the existence of a unified database—a vast network of connections among assemblages, sites and regions—into which all data retrieved from a single fragment of bone or tooth could be pooled instantaneously. Future archaeozoologists will work in the context of multidimensional data spaces performing complex analyses akin to those presently performed by biologists attempting to elucidate meaningful patterns in massive genetic codes.

Foreseeable developments in the coming decades will allow researchers to unlock and decode fully the banks of information which presently remain hidden in ancient animal bones and teeth. These achievements will be made possible through new technologies and integrative approaches already being developed today. Continued advancement will lead us towards the breakdown of those bodies of data that are contained in skeletal remains into their most basic constituents of size, shape and chemical and molecular composition.

We identify pending revolutions in three dimensions of archaeozoological data production: (1) reconstructing the size and shape of skeletal elements, (2) analyzing the chemical composition of bones and teeth and (3) deciphering the molecular composition of animals from skeletal fragments. The roots of these revolutions are observable in the present. Scientific innovations in biology, physics and chemistry are increasingly being harnessed to enhance the types, quantities and qualities of data that can be teased out of biological materials in archaeological sites.

Nonetheless, we expect to see a fundamental shift in the way that archaeozoological research is conducted only when all types of data can be fully integrated and cross-referenced within a comprehensive and unified global database of archaeozoological data. Such a breakthrough in the way that data is collected, organized and construed will bring

COURTESY OF GUY BAR OZ

There will be an app for that... the future of DNA processing

about a true leap in our level of understanding of the myriad interfaces of anthropological and biological processes throughout history. We should reach a point when scientists will be able to trace particular lineages of animals through the record across successive generations and different locations in the landscape and, quite possibly, different parts of the world; to examine corresponding changes in the size and shape of different parts of the animal skeleton, which resulted from human selection through hunting pressure or domestication; and, finally, to place animals within a coherent context of human management and adaptation to conditions in the anthropogenic environment, including changes in diet and patterns of movement.

The conventional methods of morphometry and allometry have long formed the mainstay of archaeozoology. These tools are routinely employed by practitioners in the laboratory through recourse to qualitative observations and basic methods of measurement applied to skeletal fragments. Yet this practice is rapidly being transformed by the application of digitized image analysis and computerized modeling technologies that allow capturing optimized amounts of data on shape and size in 2–3 dimensional spaces and are amenable to qualitative analysis using multivariate statistical tools. Future archaeozoologists will utilize the rapid advances in geometric morphometrics to venture far beyond the limitations of human observers. These researchers will turn data collection to an automated, highly precise process through which types of analysis nearly unimaginable only a decade ago will become routine.

Stable isotopes, which are present within the long-enduring mineral constituents of animal bones and teeth, provide archaeozoologists with indispensable tools for reconstructing dietary and movement ecologies. Analyses of carbon, nitrogen, oxygen and strontium isotopes have brought to light the intricate ways through which ancient societies manipulated animals, including their dietary composition, movement across the landscape and the trade in animal-based products, such as bone objects, ivory, shell and fur. The instrumentation and know-how to carry out these studies are already in place and are upgraded constantly. What we still lack is a comprehensive, global-scale reference map of isotopic variation along gradients crossing different environments and modes of feeding within different systems of human management. Such a reference map would provide a baseline for an accurate interpretation of isotopic data in archaeozoological materials, thereby turning isotopic analysis to an available and accessible tool for every analyst.

The most profound of the revolutions anticipated in archaeozoological research involves DNA barcoding and its application to studies of ancient animal genetics. Sequencing of ancient animal genomes from fragments of DNA preserved in skeletal remains has been a developing reality since the mid-1980s. Recent leaps in the technology used to reconstruct ancient genetic codes, only partially preserved as DNA fragments, have included next generation sequencing in conjunction with methods to control for problems of contamination. These technologies have introduced a new frontier of low-cost, reliable ancient DNA research. Realizing the full potential of this approach still awaits further technological improvements, and advances in genetic research need to progress from the current state of merely mapping complete genomes to being able to read them fully.

We see a future in which archaeozoologists can obtain with a "one-shot" technique both an identification of the species, an approach labeled barcoding, and detailed microevolutionary and phylogeographic histories of species or populations thereof even from fragments of bone presently deemed unidentifiable. This is a future in which the level of detail obtainable regarding the history of human intervention in animal genomes is virtually limitless, making much of the last tens of thousand years of cultural history itself practically an open book.

We must bear in mind that each and every fragment, including those presently deemed unidentifiable, still carries significant information which only future analysts armed with new analytical approaches and technology will be able to extract.

The weighty implication of our futuristic account is that contemporary archaeozoologists must bear a commitment not only to ensure the systematic collection of animal remains in archaeological excavations, but also to safeguard their curation for the generations of researchers to come. We must bear in mind that each and every fragment, including those presently deemed unidentifiable, still carries significant information which only future analysts armed with new analytical approaches and technologies will be able to extract. We hope that today's archaeozoologists struggling with the challenge of securing sufficient storage space for vast amounts of archaeozoological materials will be comforted by the prediction that the future also holds the promise of extraterrestrial repositories. ■

DNA barcoding uses short, unique genetic sequences—which derive from standard positions—as a way to identify species.

An **ancient animal genome** is a complete set of ancient animal DNA—including all of its genes—that contains all the information that would be necessary to build and maintain that animal.

Next generation sequencing describes several new sequencing (determining the exact order of base pairs in a DNA sample) techniques that perform parallel sequencing—millions of DNA fragments are sequenced at the same time—allowing scientists to sequence DNA in a quicker, more efficient and more cost-effective manner than previous techniques.

Microevolution refers to the process by which new biological species arise, either through natural or artificial (breeding) selection, inferred through DNA sequencing and morphological data.

Polymerase chain reaction is a technology used to amplify a single copy, or a few copies, of a piece of DNA into a multitude of copies by alternately heating and cooling a sample.

Analysis of **alleles or haplotypes** allows a profile of a unique individual to be constructed from ancient DNA. An allele is an alternative form of a gene (some genes have a variety of different forms); a haplotype is a set of alleles (aka polymorphisms), that are inherited together. Both alleles and haplotypes are unique to each individual as they are inherited from parents.