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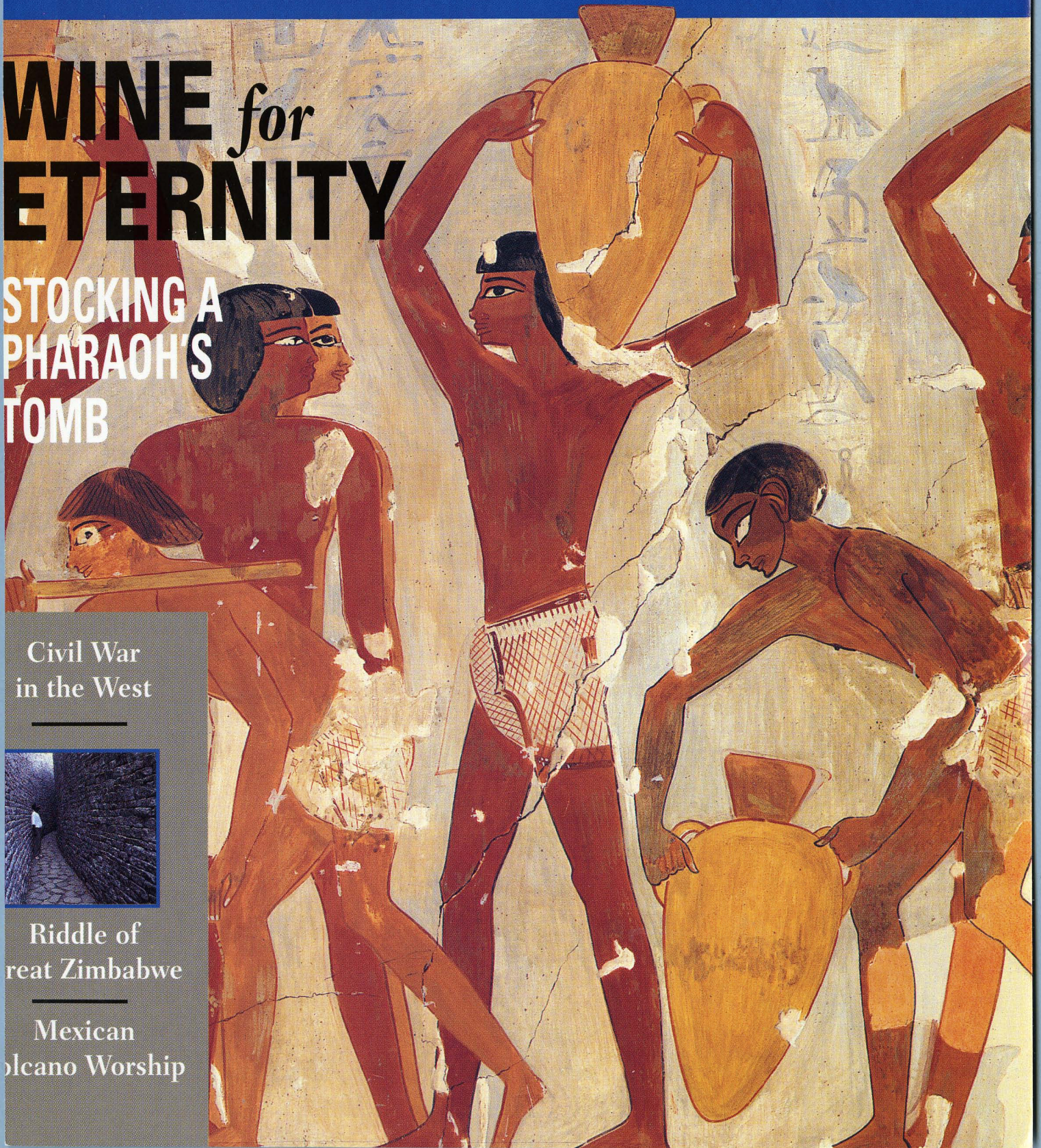
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"CELEBRATING THE HUMAN PAST"

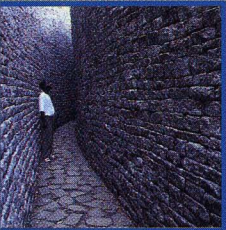
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WINE *for* ETERNITY

STOCKING A PHARAOH'S TOMB



Civil War
in the West



Riddle of
Great Zimbabwe

Mexican
Volcano Worship

Wine for Eternity

How molecular archaeologists identified the contents of vessels found in the tomb of an Egyptian king

by PATRICK E. MCGOVERN

IN 1988, GÜNTER DREYER OF THE GERMAN INSTITUTE OF ARCHAEOLOGY IN CAIRO EXCAVATED THE TOMB OF ONE OF EGYPT'S FIRST KINGS AT ABYDOS ON THE MIDDLE NILE. THE BURIAL CHAMBER OF THE KING, WHO LIVED ABOUT 3150 B.C. AND MAY HAVE BEEN KNOWN AS SCORPION I, HELD A SHRINE AND AN IVORY SCEPTER, WHILE JARS AND PLATES FOR OILS, FATS, BREAD, AND BEER, AS WELL AS CEDAR BOXES FOR CLOTHING, STONE VESSELS, AND OTHER IVORY AND BONE OBJECTS, WERE AMASSED IN SEVEN OTHER ROOMS. THE MOST AMAZING FIND, WHICH REMAINS UNIQUE IN EGYPTIAN ARCHAEOLOGY, WAS THREE ROOMS STOCKED WITH WHAT PROVED TO BE WINE JARS. THREE OR FOUR LAYERS OF



This royal tomb at Abydos, dating from about 3150 B.C., held hundreds of jars of wine (visible at bottom left).



Bottom two registers of a wall painting from the tomb of Nakht at Thebes, dating from ca. 1400 B.C., show grapes being harvested and pressed, and wine jars. Top register shows fowling.

them in two rooms, sherds from additional layers, and depressions in the floor of the third chamber suggested that the tomb held some 700 vessels. If each jar in the tomb (designated U-j by the excavators) had been filled to capacity, the total stock would have amounted to almost 1,200 gallons of wine. The jars proved to be important evidence of Early Bronze Age trade between Egypt and Palestine, encompassing modern Israel, the West Bank and Gaza, and Jordan, and set the stage for understanding the emergence of the native Egyptian winemaking industry.

Forty-seven of the 207 jars recovered contained grape pips, and several completely preserved grapes were also recovered. According to Friedel Feindt of the Botanical Institute of Hamburg University, the pips are morphologically most similar to a domesticated subspecies of grape, *Vitis vinifera vinifera*. Eleven vessels had remains of sliced

If each jar had been filled to capacity, the total stock would have amounted to almost 1,200 gallons of wine.

figs, which had been perforated, strung together, and probably suspended in the liquid. Although figs are otherwise unknown as an additive in ancient Near Eastern and Egyptian wine, they might have served as a sweetening agent or flavoring. Whole grapes were probably added for the same reasons.

How can we be sure the liquid inside the jars was wine, and not grape juice or vinegar? For one thing, it is extremely difficult to preserve grape juice. Under normal conditions and at room temperature, the natural yeast bloom on grape skins quickly ferments juice to wine. Slow-pressing methods in antiquity and high temperatures in the Middle East also contributed to rapid fermentation, which probably began even before the juice went into the jars. Moreover, the jars had clearly been sealed, most likely to keep the wine from turning to vinegar. Many clay sealings with rim and string impressions were found with the vessels. The sealings had probably been pressed onto leather or cloth covers tied over the mouths with string. Such covers would have been particularly appropriate for a young wine, from which fermentation gases still need to escape.

The volatile contents of the jars had long since disap-



Courtesy Ulrich Hartung

Neutron activation analysis of jars found in Scorpion I's tomb showed they had been made in Palestine.

peared, leaving behind yellowish rings. Chemical tests of these crusty residues, performed by the Archaeological Chemistry Laboratory of the University of Pennsylvania Museum's Applied Science Center for Archaeology (MASCA), in collaboration with research associate Donald L. Glusker and volunteer Lawrence J. Exner, confirmed the excavators' suspicion that the jars had contained wine.

The workhorse of MASCA's organic residue program is diffuse-reflectance Fourier-transform infrared spectrometry (DRIFTS), which functions on the principle that different chemical compounds absorb infrared light at different wavelengths. Wine is a complex mixture of organic compounds, including alcohols, aldehydes, acids, carbohydrates, esters, proteins, and vitamins. Polyhydroxy aromatic compounds such as tannins, anthocyanins, and flavonols give wine most of its color and taste. DRIFTS can identify such compounds or the prod-

Wine jar from another royal tomb at Abydos, together with an unprovenienced stopper bearing the name of Den (ca. 3050 B.C.), a pharaoh of Dynasty I



Photographs courtesy University of Pennsylvania Museum

ucts of their degradation in ancient residues. Tartaric acid, which occurs naturally in large amounts only in grapes, was identified in the Abydos residue using DRIFTS. A very specific test, developed by the German chemist Fritz Feigl, provided further evidence of tartaric acid. In this test, β,β' -dinaphthol and concentrated sulfuric acid convert tartaric acid to a compound that exhibits green fluorescence under ultraviolet light.

A complementary technique, high-performance liquid chromatography (HPLC), takes advantage of characteristic absorptions of chemical compounds in the near-ultraviolet and visible light regions. Testing of the jar residues with this method suggested the presence of aromatic hydrocarbons derived from the resin of the terebinth tree. This was the most definitive evidence that the jars had originally contained wine, for terebinth resin was added to wine in antiquity to prevent it from turning to vinegar.

WHERE DID THE WINE COME FROM? The wild grapevine never grew in ancient Egypt, and the domesticated subspecies was not transplanted to the Nile Delta before the end of the fourth millennium B.C. The wine jars themselves held the answer. At



MASCA, pottery is routinely subjected to neutron activation analysis (NAA), a highly sensitive technique in which very small samples are activated by high-energy neutron fluxes and their gamma-ray emissions analyzed for as many as 35 elements, including trace elements like the rare earth metals that often characterize clay sources.

The close collaboration over many years between MASCA and Garman Harbottle of Brookhaven National Laboratory, and more recently Michael D. Glascock and Hector Neff of the University of Missouri Research Reactor, has led to the compilation of a large data base of pottery and clay samples for the eastern Mediterranean and Egypt, some 1,500 from 70 sites. Combined with the Brookhaven Old World data base of 4,320 samples, it provides excellent temporal and spatial coverage of the Near East. An unknown pottery sample is compared with well-defined local compositional groups using statistical techniques. If the match is good, a sample can be said to be composed of a specific clay or to belong to a particular ancient pottery group or workshop, and thus to have been made of that clay or produced at that site.

Most of the Abydos tomb vessels are bottle-shaped jars with narrow mouths, which would have been easy to stopper and well suited to long-distance trade. According to Ulrich Hartung, who is preparing a monograph on the imported pottery from the tomb, differences in fabric, shape, decoration, and other features suggest that they came from more than one place. The best typological parallels, especially for the handled jars, are those from Tel 'Erani in the southern coastal plain of Israel, Lachish in the nearby lowlands of the Shephelah, Megiddo in the Jezreel Valley, Jericho in the Jordan Valley, Bab edh-Dhra' on the eastern shore of the Dead Sea, and Lehun on the southern Transjordanian plateau. Exact parallels for the bottle-shaped jars without handles are not known from this region in the Early Bronze Age I (ca. 3300–3000 B.C.), the period of the Abydos tomb. The relatively small number of sites that have been excavated in the southern hill country of Israel and the West Bank and in Transjordan may account for this absence. A specialized trade in wine might also have demanded special containers that would be found at relatively few sites.

Clay from 11 of the Abydos wine jars, representing all of the major fabrics in the corpus, was tested with NAA to determine its source. No identifiable Egyptian clay was used to make the jars. While three of the jars had no chemical matches with any clay sample or local group of ancient pottery in the MASCA data base, the other eight, representing a range of jar types, belong to or are closely associated with the southern coastal plain and the lowlands of Israel, the southern hill country, Jordan Valley, or Transjordan. None of the jars was chemically close to any clay or ancient pottery sample outside this region. Thus, while NAA was done on only a small proportion of the Abydos jars, the results point uniformly to a region of the southern Levant where archaeobotanical evidence exists for grapevine transplantation—and where the kinds of jars

found in the tomb are from. In Early Bronze Age I, only sites in these areas have yielded what have been classified as domesticated grape pips and whole raisins, namely, 'En Besor near Gaza, Jericho, Bab edh-Dhra', and Jawa in northern Transjordan. If we assume that the jars were manufactured near where the wine was produced, then we can reason that Scorpion I's wine came from this region.

According to NAA, the clay seals associated with the Abydos jars were made of Nile alluvial clay. Because of the clay's chemical heterogeneity, resulting from the mixing of diverse materials from upstream, the clay's precise geographic origin along the Nile cannot be determined. The finding does suggest that before the jars were deposited in the tomb, a final stoppering and sealing process took place in Egypt, perhaps at Abydos or, alternatively, at a site in the Nile Delta where the wine entered Egypt.

Archaeological investigation has established that the use of the overland trade route between the southern Levant and the eastern Nile Delta—the Ways of Horus, as it was known to the ancient Egyptians—intensified during Early Bronze Age I. The exchange in both directions of goods and even technologies, like pottery making and metallurgy, can be documented at sites along the most easterly branch of the Nile. During the latter part of the period, the Egyptians took control of the route, establishing trade centers in the southern coastal plain, notably at 'En Besor.

The jars held the answer to the wine's origins: the lowlands of Israel, the Palestinian uplands, Jordan Valley, and Transjordan.

A two-stage process in Early Bronze I interactions between Egypt and the southern Levant may account for the Abydos wine jars and the start of a native winemaking industry in the Nile Delta shortly thereafter. In the first phase, increasing Egyptian demand spurred trade in horticultural products, especially grapes and perhaps olive oil. Cultivation of the fig, an additive to the Abydos wine, had probably also begun in the southern Levant by this time. Once a market for wine had developed in Egypt, the second stage, the transplantation of grapevines to the delta and the production of wine, probably under the tutelage of foreign specialists, was possible. A thriving royal winemaking industry was established during Dynasties 1 and 2 (ca. 3050–2700 B.C.). Recent organic analyses of large jars, which were buried by the thousands in the tombs of the pharaohs at Abydos and Saqqara, provide the confirmatory evidence. Hieroglyphic seal impressions on the jar

stoppers give the name of the pharaoh, and sometimes the hieroglyph for grapevine or vineyard and the presumed location of the vineyard in the delta.

In time, the Egyptian elite came to draw on a large and refined stock of locally produced wines for both daily consumption and ritual purposes. New Kingdom tomb reliefs and paintings depict elaborate storehouses and wine cellars in the palaces and temples at Amarna and Thebes, with row upon row of amphorae awaiting royal celebrations. One such celebration was the *heb-sed* (renewal festival), in which feasts and religious rites were carried out for months to ensure a monarch's long life, the country's welfare, and the fertility of the Nile Valley. Large quantities of wine were served at the three *heb-seds* of Amenhotep III, ca. 1350 B.C., as attested by hundreds of inscribed amphora sherds found in the vicinity of the

pharaoh's palace at Malkata in western Thebes. In the Great Papyrus Harris, one of the longest and best-preserved manuscripts from ancient Egypt, Rameses III (1184–1153 B.C.) boasts of presenting 59,588 jars of wine to the chief Egyptian deity, Amun, at his temple in Thebes, a favor that was expected to be returned in the hereafter. The custom had been foreshadowed by the earliest Egyptian kings, who may have been the first to envision the preservation of wine for all eternity. Sadly for them, the treasured elixir would evaporate in musty tombs as their royal bodies turned to dust. ■

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Wine's Prehistory

Credit our Neolithic forebears with a discerning taste for the wild grape.

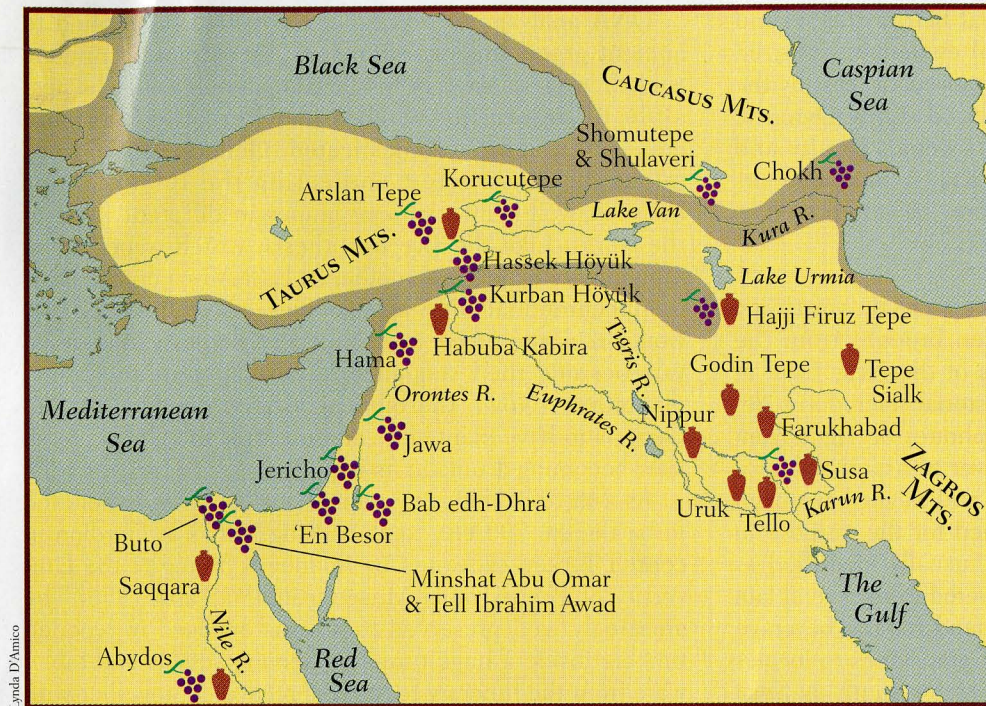
by PATRICK E. MCGOVERN

THE FASCINATION OF EGYPTIAN KINGS with wine must have been preceded by a long series of serendipitous discoveries reaching back into prehistory. Our Palaeolithic forebears might well have had a tasting or two when the wild grape came to fruition in the fall. Accidental squeezings of grape juice might have produced some wine, owing to fermentation by the natural yeast on the grape skins. Lacking adequate storage containers, such wine would have to have been drunk quickly, much like Beaujolais Nouveau, before it turned to vinegar.

The Neolithic period, from about 8500 to 4000 B.C., was the first time the preconditions for intentional winemaking came together. Communities in the ancient Near East and Egypt were permanent, year-round settlements made possible by the domestication of plants and animals. A Neolithic cuisine emerged, in which barley bread and beer, and undoubtedly an array of meat and grain entrées, were produced for the first time. Of special importance for food preparation and storage, pottery vessels were introduced around 6000 B.C. Viticulture and the craft of winemaking stood to benefit from these developments, probably contributing to ever more complex societies. To have any assurance of a dependable grape crop, the vines had to be carefully tended throughout the year, and to make the investment in land, labor, and pottery containers worthwhile, a market for the wine, provided by upper classes and royalty in permanent settlements, was needed.

Winemaking on any kind of scale required the cultivation or even the domestication of the wild Eurasian grapevine (*Vitis vinifera sylvestris*), which grows today throughout the temperate Mediterranean basin and into south, west, and central Asia. During the Neolithic, when wetter conditions prevailed, it might even have grown somewhat farther south in the Zagros Mountains of Iran and the hill country of the southern Levant. Somewhere in this vast region the wild grapevine began to be cultivated. The domesticated vine's advantages over the wild variety derive from its hermaphroditism: bisexual flowers occur, enabling self-pollination by the wind and fruit production by nearly every flower. By rooting branches or grafting one vine onto another, people then cloned hermaphroditic plants that yielded larger, juicier, and tastier fruit with fewer seeds. The Eurasian vine was ultimately transplanted throughout the temperate regions of the earth, now accounting for almost all the world's wine, whether red Merlot or white Chardonnay.

Based on current archaeological information and historical considerations, a single origin for the domesticated grapevine in some northern mountainous region of the Near East makes the most sense. Around 4000 B.C., the domesticated grapevine was transplanted from somewhere in the north to the Jordan Valley, where the wild grapevine never grew, and then around 3000 B.C., at the beginning of the Early Dynastic period, to the Nile Delta, where it formed the basis of the newly established royal



Modern regions with the wild grapevine, thought to correspond to its ancient distribution, are shaded. Early sites with grape pips, skins, or grapevine wood are marked with grape clusters, while those with wine jars are marked with jar symbols.

winemaking industry. A similar progression of the domesticated grapevine can be traced in the Zagros Mountains, along the eastern side of the Fertile Crescent.

As part of the University of Pennsylvania Museum's Hasanlu Project in northwestern Iran, Mary M. Voigt directed in 1968 an excavation at the Neolithic site of Hajji Firuz Tepe, southwest of Lake Urmia in the northern Zagros Mountains. The wild grape still grows there, and pollen cores from the lake established that it grew there in Neolithic times. During the excavation, an intriguing yellowish residue was noted on the inside lower half of a jar. At the time, Voigt thought it might be from milk, yogurt, or some other dairy product, but the chemical analysis was negative. One of the sherds from the same jar was "reexcavated" from the museum's Near Eastern storage room some 25 years later and reanalyzed using more sophisticated chemical techniques. A second jar, with a reddish residue on its interior, was also analyzed.

The battery of infrared, liquid chromatographic, and other chemical analyses, carried out by the laboratory at MASCA, clearly showed the presence of tartaric acid, calcium tartrate, and terebinth resin. The vessels had been found, together with four similar jars, embedded in the earthen floor along one wall of the kitchen of a mud-brick building dated to ca. 5400–5000 B.C. They had originally contained a liquid, judging by their relatively long, narrow necks and the fact that the residues were confined to their bottom halves. Clay stoppers of approximately the same diameter as the mouths were found nearby, indicating how the jars had been sealed. The evidence supported the conclusion that the Hajji Firuz jars originally con-

tained resinated wine, much like that placed in Scorpion I's tomb more than 2,000 years later (see page 28).

The quantity of wine in the kitchen, about 14 gallons if all six jars contained wine, suggests fairly large-scale production and consumption for a household. If the same pattern of usage were established across the whole of the site's Neolithic stratum, only part of which was excavated, one might conclude that the grapevine had already come into cultivation. One might even propose that the Neolithic residents enjoyed both red and white wines, based on the colors of the residues inside the jars, but such a romantic idea must await a more searching chemical analysis for a red-colored anthocyanin such as cyanidin and a yellowish flavonoid such as quercetin.

RELATIVELY LITTLE IS KNOWN about winemaking at Neolithic sites farther north and at higher elevations in the Taurus and Caucasus mountains, where the wild subspecies thrives today. Few Neolithic sites in this region have been excavated. Tantalizingly, domesticated grape pips have been reported from Chokh in the Dagestan Mountains of the northeastern Caucasus, dating from the beginning of the sixth millennium B.C., and from Shomutepe and Shulaveri along the Kura River in Transcaucasia, dating from the fifth through early fourth millennia B.C. Such finds, if confirmed and expanded upon by residue analysis, may point to the ultimate origins of viniculture.

Once winemaking had established itself as a viable enterprise in the Neolithic period, wine began to be traded, and as markets developed, the domesticated grapevine was transplanted farther south and into lowland regions, as we have already seen for the Jordan Valley and Nile Delta. Similar developments can be traced in Mesopotamia. By the late fourth millennium B.C. (the Late Uruk period), spouted and piriform vessels, which contained resinated wine according to the chemical tests, were being traded to the major lowland city-states, including Uruk and Tello in southern Iraq and the Elamite capital of Susa in Iran. The transplantation of the domesticated grapevine to the southern Zagros soon followed.

It has been argued that barley beer was the alcoholic beverage of choice in ancient Sumer, since grapevines are grown with difficulty in the hot, dry climate of southern Iraq and the textual evidence for viniculture and wine

drinking in Mesopotamia is minimal before the second millennium B.C. The new chemical evidence, however, shows that wine was already being enjoyed, at least by the upper classes, in the Late Uruk period. Early Dynastic (ca. 2900–2350 B.C.) cylinder seals depict royalty and their entourages drinking beer with straws from large jars and a second beverage, which can now be interpreted as wine, from hand-held cups and goblets.

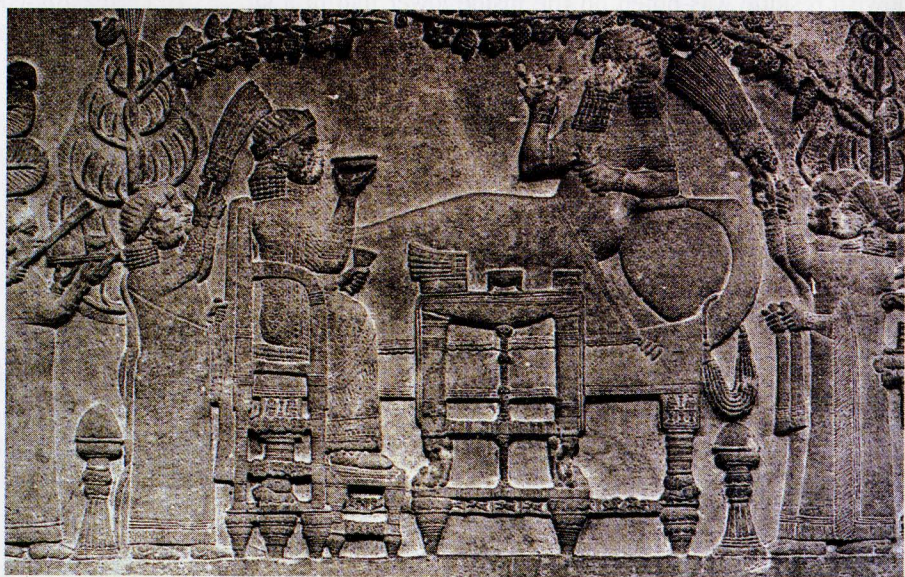
THE WINE IMPORTED INTO LOWLAND, southern Mesopotamia could have been brought from the northern Zagros or other parts of the Near East, at least 370 miles away. The Greek historian Herodotus describes shipping wine down the Euphrates or Tigris from Armenia in the fifth century B.C. River transport was also an option in the Late Uruk period, and might have been coordinated at an entrepôt established for the purpose in Upper Mesopotamia, where grapes, usually identified as the wild subspecies, have been recovered from several late fourth-millennium B.C. sites. If demand for the beverage was great enough, transplantation of grapevines to locales in the central Zagros and possibly as far south as Susa would be expected. When the Late Uruk trade routes were mysteriously cut off at the end of the period, ca. 2900 B.C., the pressure to establish productive vineyards closer to the major urban centers would have intensified.

The late fourth- and third-millennium B.C. site of Tepe Malyan (the ancient Elamite capital of Anshan) in the Shiraz region of the southern Zagros has yielded numerous grape pips and even grapevine wood, identified by MASCA's archaeobotanist, Naomi F. Miller. These finds indicate that the domesticated plant had already been transplanted to the southern Zagros by at least the mid-third millennium. Images on Elamite cylinder seals, foreshadowing scenes on the Assyrian reliefs of Assurbanipal two millennia later, depict males and females seated under grape arbors drinking what is most likely wine from cups.

The story of wine is in many ways the story of civilization—its possible beginnings in the small, mountainous Neolithic villages of the Near East and its spread to lowland Egypt and Mesopotamia and eventually around the world. The archaeological chemistry of ancient wine, however, is only in its infancy. Organic compounds, which until recently could only be surmised from ancient writings or ethnographic analogies, are now routinely detected by highly sensitive laboratory instruments. Combined with inorganic proveniencing techniques such as neutron activation analysis, these tests are helping archaeologists to reconstruct ancient trade routes and economies. But there is much to learn.

DNA analysis, for example, has yet to be applied to ancient grape and wine remains. By extracting nucleic acids from desiccated or fossilized material, it may be possible to determine when and where the Eurasian grapevine was first domesticated. Genetic family trees might be constructed, indicating the relationships between well-known varietal grapes in different parts of the world. Like the Eve hypothesis, which traces all of humanity to an original mother in East Africa on the basis of mitochondrial DNA lineage trees, a “Noah” hypothesis would seek the progenitor of modern domesticated grape varieties and their sequence of development and transplantation. (Noah, the biblical “first vintner,” is said in Genesis to have planted a vineyard after the Great Flood, later becoming drunk on its wine.)

As a taste of things to come, consider what is believed to be the ca. 700 B.C. tomb of King Midas at Gordion in central Turkey, excavated by Rodney S. Young of the University of Pennsylvania Museum in 1955 and 1956. The amazingly well preserved tomb was encased in wooden timbers inside a huge tumulus. Serving vessels and tableware from the funerary feast were recovered, together with elaborately inlaid furniture. Among the drinking vessels were a lion-headed and a ram-headed bronze situla, or bucket. Pottery bowls within large metal cauldrons still held the remains of the final meal for family and friends. The MASCA laboratory recently began to reinvestigate the contents of these artifacts, in an effort to determine what the ancient Phrygians were eating and drinking on that momentous occasion. Already we have an inkling. When the excavators first opened the tomb, they are said to have been overcome by the smell of “stew.” It would appear to have been a lamb stew washed down with a mixed fermented beverage of wine, barley beer, and honey mead. Only chemical analysis will allow us to know for sure. ■



Assyrian relief depicts the king Assurbanipal (668–627 B.C.) and his queen banqueting under a grape arbor.

Courtesy The British Museum