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ARTICLE

Plants and mudbrick: preserving the Midas Tumulus at Gordion, Turkey

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ABSTRACT

Gordion was the capital of ancient Phrygia and reputed home of King Midas (c. 700 BC). Its monuments include the Midas Tumulus, nearly a hundred smaller burial mounds and the ancient city of Gordion itself. Agricultural development and the natural forces of wind and water erosion threaten the integrity of these mounds. In order to preserve the monuments, the Gordion Project is attempting to create a solid cover of grasses and flowers on the Midas Mound. Both archaeological conservation and the preservation of biological diversity are served best by encouraging native plants to grow. To that end, a fence was erected in 1996, and lining the erosion channels with unbaked mudbrick has proved a successful experiment.

The story of King Midas has come down to us through mythology and Herodotus' *Histories*, and in the past century Phrygian inscriptions and Assyrian texts have been found attesting to the historical reality of at least one king named Mita [1]. Gordion, the capital of ancient Phrygia, was the reputed home of King Midas (c. 700 BC). The ancient settlement was occupied from the Early Bronze Age to the medieval period, and nearly 100 burial tumuli dating to the Phrygian period dot the landscape around the site. Rising to a height of 53m, with a diameter of about 250m, the Midas Tumulus stands out in the landscape as a special place (Figs 1 and 2).

Since the 1950s, a team sponsored by the University of Pennsylvania Museum has been investigating the ancient settlement ('City Mound') as well as a number of the burial mounds, including the Midas Tumulus. In 1957, archaeologists found the approximate location of the Midas tomb chamber by drilling, and reached it by tunnelling in from the south side. Excavation revealed that at the base of the large earthen and stone mound lay a wooden log cabin-like structure in which the skeleton of a man was accompanied by a variety of bronze and pottery vessels, food offerings and wooden furniture. The tomb

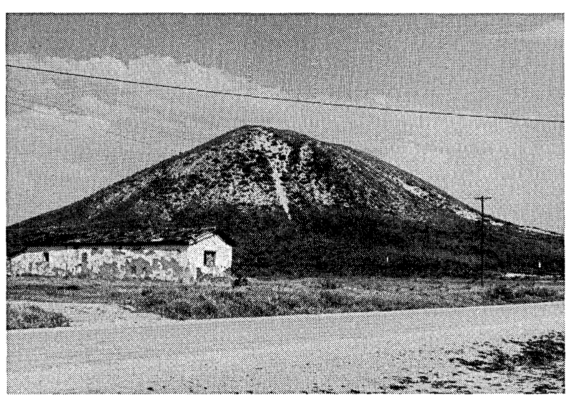

Figure 1. Midas Tumulus (June 14, 1998). Fence posts 6 and 7 appear in white to the right and left of the telephone pole. Erosion channel 2 is in the center of the picture.

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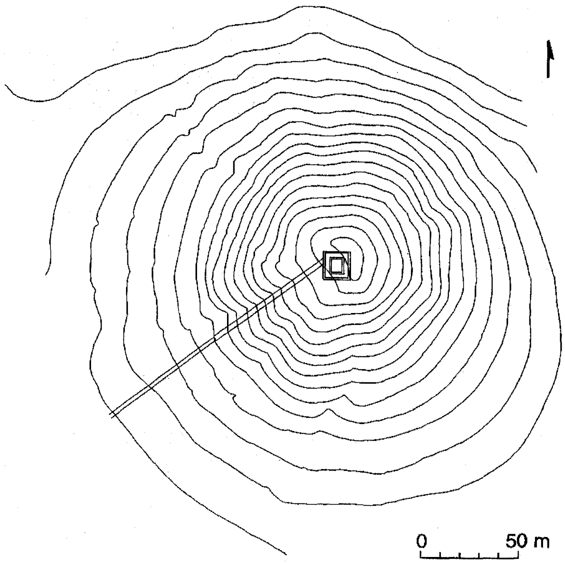

Figure 2. Midas Tumulus with 3-metre contour intervals for the 53m high mound. Figure shows location of concrete enclosed tomb chamber and passage. Redrawn from Young (1981: Fig 50)

held no gold [2]. Although no textual evidence proves that the Midas Tumulus was Midas' burial place, or indeed that ancient and modern 'Gordion' are one and the same, those ancient names are most plausibly applied to the Midas Tumulus and City Mound. These associations are certainly the biggest draw for tourists. About 40 years ago, the tunnel and space around the chamber was stabilized with stone and concrete, so that today visitors can view the tomb by walking around 100m to the centre of the mound (the stabilized tunnel to the centre is 68m long). The conservation of the Midas Tumulus, under the direction of G. Kenneth Sams, has mostly been concerned with the interior [3–6]. The artefacts, including the spectacularly conserved wooden furniture [7], are in the Museum of Anatolian Civilizations in Ankara.

Gordion lies about 90 km southwest of Ankara. The Midas Tumulus and a small museum across the street are in the village of Yassihöyük. Although the archaeological precinct comprising the City Mound and tumuli is not as big an attraction as it ought to be, a steady stream of schoolchildren and Turkish and foreign tourists do visit. Yassihöyük has the potential to become a major tourist destination if we take a broad view of the project's archaeological, preservation and educational mission. This article deals with one small piece of that larger picture.

PLANTS IN THE SERVICE OF ARCHAEOLOGICAL PRESERVATION

Several years ago, Dr Ilhan Temizsoy, Director of the Museum of Anatolian Civilizations, expressed concern about soil erosion on the outside of the Midas Tumulus. As erosion caused by wind and water constitutes the major threat to the mound surface, the most effective way to reduce soil loss would be to get an uninterrupted cover of plants to grow on the mound. Plant cover would keep the strong Anatolian winds from blowing soil away, would reduce the force of water reaching the soil surface and, as the roots of plants take up water, the total volume of water reaching the bottom of the mound would be reduced. Discontinuous plant cover on the mound resulted from several factors. The slopes are very steep, especially toward the top. Animals were allowed to graze on the mound, local young people would play on it, riding bicycles or even motorcycles, and tourists would climb it for the view.

The first step was to encourage extant vegetation to spread by erecting a fence to keep animals and people off the mound [8], which was done in April 1996 by the General Directorate of Monuments and Museums. Although there was no obvious improvement in the plant cover in the summer of 1996, Miller collected some seeds for the site's caretaker to plant to the right of the tomb entrance. Following a suggestion of Dr Temizsoy, he also transplanted three *Stipa arabica* (a type of feathergrass) from inside the fence of the Gordion city mound. None of the seeds sprouted and only one of the three transplanted *Stipa* survived until the summer of 1997.

By the summer of 1997 it was clear that the fence was having an effect; grasses and other plants were beginning to spread, especially on the lower slopes of the north side of the mound; trails beaten by passing flocks of grazing animals were shrinking as well. We surveyed the distribution of vegetation on the mound. The most serious problem was the erosion channels. Since the force of water flowing in the channels was great enough to move stones, Miller thought that mudbrick might be suitable to line the channels. Bluemel agreed, and directed how the bricks should be set [9]. In 1998, a programme for monitoring the vegetation was developed.

What plants are best for the purpose?

No one type of plant is best. The mound experiences a variety of wind and weather conditions. It also is characterized by many different zones, with slopes facing all directions and with different moisture conditions on the upper and lower areas. A wide variety of plants would ensure something would always do well, in a dry, wet, cold or hot year. The native steppe vegetation of central Anatolia provides a particularly appropriate set of plants [10]. It has evolved in the environment of the mounds, and, once established, should not require watering or expensive care. The native vegetation includes many perennial plants which stay green well into the summer or year-round. Therefore, even when the spring wildflowers are gone, there should be some green on the tumulus.

From an archaeological perspective, we have no idea what, if any, plants grew on the tumulus in antiquity, so it is neither possible nor desirable to return the mound surface to some hypothetical original state. Analysis of archaeobotanical remains from recent excavations under the direction of Mary M. Voigt suggests that in antiquity there was a gradual loss of tree cover in the vicinity of the site, as well as some decline in pasture quality [11]. A survey of the modern vegetation suggests that despite a high degree of disturbance, enough of the native vegetation remains so that tourists will have at least some idea of what the ancient steppe might have looked like.

Two possible effects of revegetation could have negative consequences for the preservation of the tomb: changes in moisture balance and root penetration. These probably will not cause problems on the Midas Tumulus. The excavated space in which the log tomb chamber stands is now encased in concrete since the stabilization of the tomb carried out forty years ago, so any moisture changes in soil around and above the chamber probably would not affect its interior humidity. As for the problem of root penetration, many of the plants that grow on the mound have quite shallow root systems, most notably the grasses. One type does have a very long taproot, camel thorn (*Alhagi*), but it grows only on the lower slopes of the tumulus. Nevertheless, on the smaller tumuli at Gordion and on other archaeological sites, root penetration could be a significant problem in some situations. Eliminating deep-rooted shrubs, even 'naturally' occurring ones, might be advisable in those cases.

Native wild plants for the tumulus

Getting wild plants to grow is not a simple matter of throwing seeds on the ground. We had hoped to speed the revegetation process by planting seedlings grown under relatively controlled conditions. One of our greatest problems was getting enough seeds from suitable wild plants. The local vegetation is under such stress that it would not be a responsible act to collect seed intensively from the wild. Also, if the limiting factor in a revegetation programme is obtaining enough seed, in the wild as few as 1 or 2% of seeds survive, whereas a successful cultivator might be able to get more than 50% to sprout. We collected some wild seed from the mound in 1997. Types were chosen for variety, palatability to grazers, visual attractiveness or availability (Table 1). A few of the types had not previously been seen on the mound,

Table 1. Taxa unsuccessfully sown in planting pots, 1997–8.

Perennials	Annuals
Acanthaceae (acanthus family), *Acanthus*	Asteraceae (daisy/thistle family), *Achillea, Centaurea pulchella, Crepis, Matricaria/Anthemis*
Caryophyllaceae (pink family), *Petroraghia*	Cistaceae, *Fumana*
Lamiaceae (mint family), *Nepeta, Salvia*	Fabaceae (bean/clover family), *Medicago minima, Trigonella monantha, Trigonella* sp.
Liliaceae (onion family), *Allium*	Papaveraceae (poppy family), *Papaver*
Poaceae (grass family), cf. *Agropyrum, Bothriochloa, Bromus cappadocicus,* cf. *Festuca, Hordeum bulbosum, Melica ciliata, Phleum,* cf. *Poa, Sesleria, Stipa arabica, Stipa* sp.	Ranunculaceae (buttercup family), *Consolida, Nigella* cf. *arvensis*
	Poaceae (grass family), *Bromus japonicus, Bromus tectorum, Hordeum murinum, Taeniatherum caput-medusae, Triticum boeoticum,* two unidentified types (each c. 1 m)

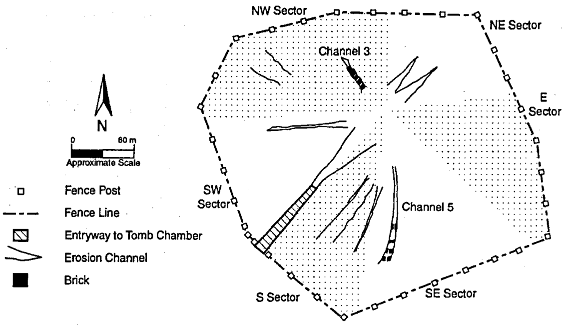

Figure 3. Sketch plan of erosion channels. Sectors were defined by informally observed changes in vegetation.

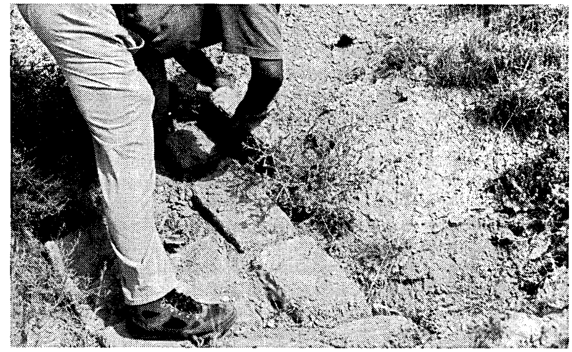

Figure 4. Setting mudbrick in erosion channel 3 (July 24, 1997).

although they were from plants growing within about 10km of the village. By 1998 the vegetation had recovered so well that we will just collect from the mound itself in future, and so have no plans to introduce new types. Although we are still trying to develop ways to grow seedlings to transplant on the Midas Tumulus, to date we have not succeeded.

Thanks to the fence and the particularly wet winter of 1997–8, a substantial amount of vegetation has regenerated on its own. Indeed, now that sheep and goats no longer graze there, the lower slopes need no further attention (Fig. 1). It is more difficult for the vegetation to become established in the erosion channels and on the steepest of the upper slopes.

MUDBRICK FOR EROSION CONTROL

Ordinarily, archaeological restorations distinguish original structures from modern repairs and restorations. Since the mound is composed of earth and rocks, any stabilization using those materials would blend in with the present-day surface of the mound. Landscaping cloth would be too expensive. Any solution requiring heavy equipment is also out of the question due to the fragility of the mound surface. Mudbrick seems to be the most reasonable substance to use, although it would, after a few years, become indistinguishable from the rest of the mound. In any case, as dust storms are fairly common in the area, not all of the sediments on the surface of the mound are ancient and anthropogenic.

We began developing methods to heal the erosion channels (Fig. 3). Two erosion channels were chosen: erosion channel 3 on the northwest side of the Midas Tumulus and erosion channel 5 on the south-east side. We chose to set mudbrick in the channels because it was clear that the force of water flowing in the channel could move even fairly large stones down the slopes (Fig. 4). The unbaked mudbrick was also expected to melt slowly into the channel as the winter rains progressed. A thousand mudbricks (each about 40 x 20 x 10cm) from a dismantled structure were purchased. Since the mound surface is soft, it cannot take the weight of vehicles or heavy equipment without damage. The site caretaker therefore arranged to have the mudbricks delivered outside the fence and he hired five workers to carry and place them. The workers were asked to start from the bottom, stepping on the bricks as they proceeded upward. About 1000 bricks were laid and the work was extremely arduous. The crew worked for two very long days.

Erosion channel 3 (NW sector)

About 700 bricks were laid carefully, lining the channel for a distance of about 35–40m, but spaced in rows about 5cm apart. We collected wild seed from annuals and perennials for the caretaker to distribute. The perennials included grasses (*Agropyrum*, cf. *Festuca*, *Melica ciliata*, and *Phleum* cf. *Poa*) and a few *Salvia*. The annuals included grasses (*Bromus tectorum*, *Hordeum murinum*, *Taeniatherum caput-medusae*, two unidentified types), one legume (a *Trigonella*), and several composites (*Achillea wilhelmsii*, *Centaurea pulchella*, and *Crepis*). Sprinkled be-

Figure 5. Sprinkling seeds in erosion channel 3 (July 24, 1997).

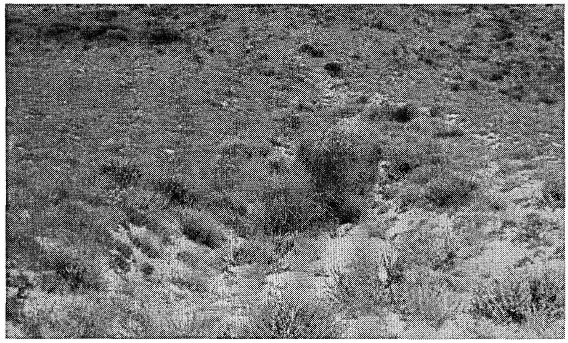

Figure 6. Erosion channel 3 with plants (June 19, 1998).

tween the bricks and protected from wind, water and birds, the seeds would have a chance of sprouting (Fig. 5). Three of the planted annual grass types (*Bromus tectorum*, *Hordeum murinum*, and an unidentified type) took root and are flourishing. In addition, a variety of wild plants that seeded themselves are growing in the channel among the grasses (Fig. 6). Even newly laid mudbrick is not visible to the casual tourist due to the irregularity of the mound surface and the distance from the fence to the erosion channel. After one winter, the vegetation in the erosion channel was barely visible as a green and brown stripe from about one half kilometre. As the surface stabilizes, the surrounding vegetation should spread into the channel rendering it completely invisible.

Erosion channel 5 (SE sector).

This channel was particularly active, but it is visible from the road. We could not risk failure and a large pile of dissolved mud brick at the base of the mound. Therefore, as an emergency measure, we had mudbrick rows spaced every 30cm instead of every 5cm. Three hundred bricks were set out over a linear distance of about 30–35m. The caretaker put a very small amount of collected seed there. Soil from above filled some of the spaces between the mudbrick rows, and, of the seeds planted, only one of the annual grasses sprouted in a few spots. The channel, especially where the bricks are and downhill from the bricks, has many plants growing, both perennial and annual (Fig. 7). As with channel 3, the dissolving bricks are largely hidden by new growth, and so after one winter cannot be seen easily, even from a distance of two metres. The mudbrick is invisible from the edge of the mound.

Figure 7. Erosion channel 5 with dissolving mudbricks and plants (June 24, 1998).

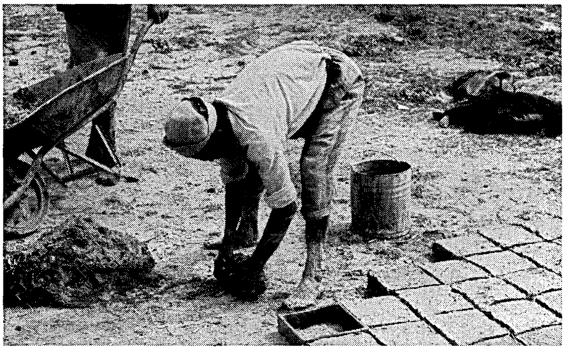

Figure 8. The making of mudbrick. The photograph was taken in Iran, but the technique illustrated is widespread throughout the Near East.

One advantage of old brick is that it is dry and therefore lighter than new brick. For those who might wish to try this technique elsewhere, and where old bricks might not be available, traditional mudbrick manufacture requires dry weather and relatively simple tools and facilities. A slurry of mud and chopped straw is put in a wooden mould on the ground; the mould is lifted, and the process is repeated. After the bricks have dried a little, they can be flipped on end to speed the drying process (Fig. 8). Houben and Guillaud provide a description of manual and mechanized production techniques [12]. One could experiment with size and composition to optimize dissolution. In addition, one could incorporate desired seed types within the mud matrix [13]. This could be particularly useful if the bricks must be spaced far apart and there is scant existing vegetation to colonize the area or if insect predation were a problem. Another significant advantage of the method just described is its low cost. Labour and materials for filling two channels partway (a total of about 35–40 linear metres for channel 3 and 30–35 linear metres for channel 5, cost under $1000.

MONITORING THE RESULTS: VEGETATION SURVEY

The winter of 1997–8 was the wettest for many years, so the vegetation was particularly lush in the spring of 1998. It seemed most important to document past work and current conditions, in order to be able to assess the usefulness of these developing methods. To that end, Miller made a map of the mound, surveyed the vegetation growing in six transects and took many record photographs.

Methods

In order to assess our progress, it is important to know what is growing on the mound at present. A series of vegetation transects seemed the most efficient way to provide baseline data [14] (Fig. 3).

First, the cement posts of the fence were numbered from 1 to 33, starting at the left of the entrance gate. Between each cement post, 8 to 11 metal posts are spaced approximately 3m apart, which made it possible to roughly scale the distances between posts. Fortunately, the fence forms an irregular polygon, and with the help of a compass and some adjustments, it was possible to produce a reasonably accurate sketch map of the mound.

There was not enough time to do a transect from each post, yet it is obvious even to the casual observer that the vegetation varies around the mound. Therefore, at each of the numbered posts, the most obvious vegetation at the base of the mound was noted along with an impression of vegetation cover. Rough boundaries that could define sectors were then defined. In that way, six sectors were delineated: SW, NW, NE, E, SE, and S.

A ring of about $1m^2$ in area (3.54m circumference) was made from a length of garden hose. The hose was not stiff enough to make an exact circle, but for monitoring purposes it seemed adequate. Starting from one post in each sector (chosen partly to be not too close to the previous transect, and partly to avoid major erosion channels and the steepest slopes), the hoop was set down every 15 paces (approximately 10m) and Miller listed the plant types seen within (Fig. 9). The slope and percentage of area covered by plants (except for post 3 transect) was estimated in a very subjective way. The condition of the vegetation was noted: whether the taxa were in a vegetative state, flowering, fruiting or dry. In addition, in a separate page of the notebook, other types seen growing in the vicinity of the hoop but not actually within it were noted. In the course of the week, the plants got riper and in a few cases Miller's identifications improved. Some of the plants unfamiliar to the investigator were collected, but a few were so rare

Figure 9. Vegetation survey. Tallying plants along a transect in units of one square metre.

that they were left to grow undisturbed. Therefore, the data collected represent the smallest number of different types.

Results of the transect survey

The variety of plants growing on the tumulus is impressive: from about 36 types in the transect of the NE sector to about 70 types in the transect of the E sector). The total number of distinct taxa (not all of which Miller has been able to identify) is about 125 (Table 2). It is also clear that some plants are affected by aspect, and others by elevation; the northern side tends to be more favourable to plant growth, and run-off makes the lower slopes substantially wetter than the upper ones. For example, one perennial grass, *Stipa arabica*, does very well in the southeast sector, while *S. holosericea* is most abundant in the south sector. Some of the present distribution has probably been affected by the history of grazing, for example, the prevalence of spiny plants (e.g. thistles [cf. *Onopordum*], *Centaurea solstitialis*), *Hordeum murinum*, and *Peganum harmala* on the lower slopes reflects the fact that grazing has been most intense towards the base of the mound, favouring the survival of these anti-pastoral types. An example of the data collected for the transect from post 20 (E sector) appears in Table 3. The fence appears to have allowed a slightly more diverse group of plants to survive, including a slightly higher percentage of pasture plants (Table 4). The mapping demonstrates that there is no one plant or even group of plants that appears to be best for the mound's preservation.

Niçin Midas Tümülüsü'nün etrafı dikenli tel çevrili?

Midas Tümülüsü'nün üzerindeki bitki örtüsünü koruyarak ve çoğaltarak erozyonu mümkün oldukça azaltmaya çalışıyoruz. Bu dikenli tel bitkilerin insanlar ve heyvanlar tarafından ezilmelerini ve bozulmalarını engellemek için çekilmiştir.

Midas Tümülüsü'nün üzerinde yürümediğiniz için teşekkür ederiz.

Why is there a fence around the Midas Tumulus?

We hope to slow erosion by improving the vegetation cover. The fence protects plants from trampling by people and grazing by animals.

Thank you for not walking on this mound.

Figure 10. Text of sign proposed for outside Midas Tumulus (Turkish translation by Elif Denel).

FUTURE PLANS

For now it is most reasonable to let plants spread on the lower slopes without assistance. Intervention in the erosion channels has a lot of potential, but should proceed slowly, as we are still refining our methods. Both annuals and perennials can establish themselves on the upper and lower mound slopes and in the erosion channels; our own interventions have been most successful with annuals. Ultimately, we would like to see a high proportion of perennial tufted grasses, like *Stipa arabica*, *S. holosericea* and *Bromus cappadocicus* that grow elsewhere on the tumulus. But we may have to wait until the annuals create a stable soil surface to let the more desirable perennials spread on their own, as they seem to be doing in the northwest sector.

We are continuing to set mudbrick in the erosion channels. Between the rows of bricks we are distributing a mixture of seeds (mostly annual grasses and some perennials collected in the summer of 1998 from the increasingly lush vegetation on the mound itself). Finally, although previous plant-propagating efforts have failed, the site caretaker will try again to grow some annuals in planting cells. Even though we were unable to propagate wild seed last year, if we could establish seedlings in the erosion channels, fewer bricks might be needed. Also, if the upper slopes remain partly bare, it will be useful to have an easily renewable source of appropriate wild seed and seedlings.

Education will become part of the project. We are hoping to erect a permanent sign with text in Turkish and English on posts near the Midas Tumulus, explaining why the fence was erected (Fig. 10). In addition, Miller has explained the

Table 2. Taxa seen on Midas Tumulus, June 1998*.

Taxon**	SW	NW	NE	E	SE	S
Apiaceae (carrot family)						
Bupleurum cf. *turcicum*	.	.	.	E-20	.	.
•*Eryngium* (blue) (NM 1778)				.	.	S
•*Eryngium* (green) (NM 1971)	SW-3	NW-9	NE-15			
•*Eryngium* (tall)	.	.	.	E-20	SE	S
Asteraceae (daisy/thistle family)						
Achillea wilhelmsii	SW	NW-9	.	.	.	.
Achillea (NM 2364)	.	.	NE	.	.	.
Artemisia	SW-3	NW-9	NE-15	E-20	SE-26	S-30
•*Carduus nutans*	SW-3	NW-9	NE	E	.	S-30
•cf. *Carduus pycnocephalus*	.	.	.	.	SE-26	S
Centaurea patula	SW-3	NW-9	NE	E-20	SE-26	S-30
Centaurea cf. *pseudoreflexa*	.	NW-9	NE-15	E-20	SE	.
Centaurea pulchella	SW-3	NW-9	.	.	SE-26	S-30
•*Centaurea solstitialis*	SW-3	NW-9	NE-15	.	SE	S-30
Centaurea virgata	.	NW-9	NE	E-20	SE-26	S-30
•*Centaurea* (NM 2426)	SW	NW-9	.	E	SE	S-30
Centaurea (NM 2423)	.	.	.	.	SE	.
cf. *Conyza* (NM 2361)	SW-3	NW-9		E-20	SE-26	S-30
•*Cousinia halysensis*	SW-3	NW-9	NE-15	E-20	SE-26	S-30
Crepis	.	.	.	E-20	SE-26	S
•*Gundelia tournefortii*	SW-3	.	NE	E	SE	S-30
Koelpinea cf. *linearis*	SW-3	.	.	E-20	SE-26	S-30
+*Lactuca serriola*	.	NW	.	.	SE-26	S-30
Matricaria/Anthemis	SW	NW	NE	E-20	SE-26	S-30
•*Onopordum* cf. *anatolicum*	SW-3	NW-9	.	E-20	SE-26	S-30
cf. *Scorzonera*	.		.	.	SE	S
Taraxacum	.	NW	.	.	.	.
Tragopogon cf. *dubius*	SW	.	.	E-20	SE-26	S-30
Xeranthemum inapertum	.	.	.	E-20	SE	S-30
NM 2344	.	NW-9	.	E-20	SE	S-30
NM 2387	.	NW	.	.	SE-26	.
Boraginaceae (borage family)						
• *Alkanna*	SW-3	NW-9	NE-15	E-20	.	.
Rochelia disperma	.	NW-9	.	E	SE-26	.
Brassicaceae (mustard family)						
Alyssum cf. *blepharocarpum*	SW	NW-9	NE-15	E-20	SE-26	S-30
Matthiola longipetala subsp. *bicornis*	.	.	.	E-20	SE-26	S-30
cf. *Sisymbrium loeselii*	SW-3	.	.	.	.	.
cf. *Torilis*	.	.	NE-15	.	.	.
Caryophyllaceae (pink family)						
cf. *Bufonia*	.	.	.	E-20	.	S-30
Gypsophila eriocalyx	SW-3	NW-9	NE	E		S
Gypsophila viscosa	SW-3	.	.	.	SE-26	S
cf. *Minuartia*	SW-3	NW-9	NE	E-20	SE	S-30
Petrorhagia	SW-3	.	.	E-20	.	S
Silene (NM 2415)	.	.	NE-15	E-20	SE-26	S-30
cf. *Stellaria media*	SW-3	NW-9	.	E-20	SE-26	.
Allochrusa versicolor	SW-3	NW-9	NE	.	SE	.
NM 2389	.	NW-9	NE-15	.	.	.
Chenopodicaceae (goosefoot family)						
Krascheninnikovia ceratoides	SW-3	NW-9	NE-15	E-20	SE-26	S-30
•cf. *Noaea mucronata*	SW-3	NW-9	.	E-20	SE-26	S-30
Cistaceae						
Helianthemum salicifolium	SW-3	NW-9	.	E	SE-26	S-30
Convolvulaceae (morning glory family)						
Convolvulus lanatus	.	NW-9	NE	E-20	.	S-30
Dipsaceae (teasel family)						
Scabiosa	SW-3	NW-9	NE	E-20	SE-26	S-30
Euphorbiaceae (spurge family)						
+*Euphorbia* (NM 2385)	SW-3	NW-9	.	E-20	.	S-30
Fabaceae (bean/clover family)						
•*Alhagi pseudalhagi*	SW-3	.	.	.	.	.
Astragalus cf. *lycius*	SW-3	NW-9	NE-15	E-20	SE	S-30
Astragalus lydius	.	NW-9	.	.	.	.
Astragalus triradiatus	SW-3	.	.	E-20	SE-26	S-30
Astragalus (NM 2347)	SW-3	.	.	E	SE-26	.
Astragalus (NM 2377)	SW-3	NW-9	NE	E-20	SE-26	S-30
Astragalus cf. *macrocephalus*	.	.	NE	.	.	.
Hedysarum cf. *cappadocicus*	.	.	NE-15	.	.	.
Medicago constricta	SW-3	.	.	E-20	SE-26	S-30
Onobrychis	SW-3	.	NE-15	E-20	SE	S
Trigonella astroites	SW-3	NW-9	.	E-20	SE-26	S-30
Trigonella coerulescens	SW-3	.	.	E-20	SE-26	S
Trigonella monantha	SW-3	NW-9	.	E-20	SE-26	S-30
Trigonella cf. *pycnocephalus*	.	.	.	E-20	.	.
Trigonella (NM 2410)	.	NW-9	.	E-20	.	.
Trigonella (NM 1257)	SW-3	NW	NE	E-20	SE-26	S-30

Table 2 continued

Taxon**	SW	NW	NE	E	SE	S
Geraniaceae (geranium family)						
Erodium cicutarium	SW-3	NW-9	.	E-20	SE-26	S
Illecebraceae						
Herniaria incana	SW-3	NW	.	.	SE	.
cf. *Scleranthus*	SW	.	NE-15	E-20	SE-26	.
Lamiaceae (mint family)						
Acinos rotundifolius	.	.	.	E-20	.	.
Marrubium	.	NW	NE	.	.	.
Scutellaria orientalis subsp. *pinnatifida*	.	NW	NE-15	E-20	.	.
Teucrium polium	.	NW-9	.	.	.	S
Thymus (small fl.) (NM 1443)	.	NW-9	NE-15	E-20	SE-26	S-30
Thymus (large fl.) (NM 2383)	SW-3	NW-9	NE-15	E-20	SE	S-30
Ziziphora taurica	SW-3	NW-9	NE-15	E-20	SE-26	S-30
Linaceae (flax family)						
Linum cf. *bienne*	.	.	NE-15	.	SE	.
Orobanchaceae						
cf. *Orobanche*	.	NW	NE	E	SE-26	S
Papaveraceae (poppy family)						
Glaucium (no black in center)	SW-3	.	.	E-20	SE-26	S-30
Glaucium (black center)	.	NW-9	.	E-20	SE-26	S-30
Glaucium (pod only)	SW-3	.	.	.	.	.
Hypecoum cf. *imberbe*	SW-3	.	.	E-20	.	S
Papaver cf. *hybridum*	SW-3	.	.	.	.	.
Papaver cf. *lateritum*	.	NW-9	.	.	.	.
Papaver sp.	.	.	NE	.	.	.
Plumbaginaceae						
•*Acantholimon* cf. *venustum*	.	NW-9	NE	E-20	.	S
Ranunculaceae (buttercup family)						
Aconitum cf. *nasutum*	.	.	.	E	SE-26	S
Adonis	.	NW-9	.	E	SE-26	.
cf. *Consolida*	.	NW	.	.	SE-26	.
cf. *Delphinium*	.	.	.	E-20	.	S
Nigella arvensis	SW-3	NW-9	.	E	SE	S-30
Resedaceae						
Reseda lutea	.	NW-9	NE	E	.	S
Rubiaceae (bedstraw family)						
cf. *Asperula* (NM 240)	.	.	NE	.	.	.
Thymelaeaceae						
Thymelaea cf. *passerina*	SW-3	NW-9	.	E-20	SE-26	S-30
Zygophyllaceae						
+*Peganum harmala*	SW-3	NW-9	NE-15	E-20	SE-26	S-30
Family unknown						
NM 2379 (sub-shrub)	SW-3	NW-9	NE-15	E-20	SE-26	S-30
NM 2375 (<10 cm, herbaceous)	SW-3	NW-9	.	E-20	SE-26	S-30
NM 2372 (v), = NM 2401?	.	.	.	E-20	SE-26	S-30
•red parasite	.	.	NE-15	E-20	.	.
•mushroom	.	.	.	E	.	.
Liliaceae (lily family)						
Allium (NM 2380)	SW-3	NW-9	NE	E-20	SE-26	S-30
Allium (NM 2424)	.	.	.	.	SE	.
Poaceae (grass family)						
•*Aegilops* cf. *cylindrica*	SW-3	.	NE	.	.	S-30
•*Aegilops triuncalis*	SW-3	NW-9	.	.	.	S-30
cf. *Agropyron cristatum*	.	NW-9	NE-15	E-20	.	S-30
cf. *Briza humilis*	.	NW	NE-15	E-20	SE	.
Bromus cappadocicus	SW-3	NW-9	NE-15	E-20	SE	S
Bromus cf. *japonicus* (smooth)	SW	NW-9	.	E-20	.	S
Bromus cf. *japonicus* (hairy)	.	NW-9	NE-15	E-20	SE-26	S-30
Bromus cf. *tectorum*	SW-3	NW-9	NE-15	E-20	SE-26	S-30
Cynodon dactylon	.	.	.	E-20	SE-26	.
Eremopyrum (NM 2381)	SW-3	NW-9		E-20	SE-26	S-30
Eremopyrum (NM 2404)	.	.	NE-15	.	.	.
•*Hordeum murinum*	SW-3	NW-9	NE-15		SE-26	S-30
Phleum (NM 2382)	.	NW-9	.	.	.	S-30
Poa/Festuca	.	NW-9	NE-15	E-20	SE-26	S-30
Sesleria	.	NW-9	NE-15	.	.	.
Stipa arabica	SW-3			E-20	SE-26	S-30
Stipa holosericea	SW-3	NW-9	NE-15	E-20	.	S-30
Triticum durum	.	.	.	.	.	S
NM 2355=NM 2365	.	NW-9	NE-15	E-20	.	.
NM 2368	SW-3	NW-9	.	E-20	.	S-30
NM 2369	SW-3	NW-9	.	.	.	.
NM 2370	SW-3	NW-9	.	.	.	.

* Taxa included in census indicated by Sector followed by post number.
** (NM xxxx) are voucher specimens collected by N. F. Miller; for descriptions of named taxa see the ten-volume *Flora of Turkey* (Davis 1965-88). Even when young, physically (with spines/hairs) [•] or chemically [+] unattractive to grazers).

Table 3. Sample transect, East Sector (from Post 20 to top of Midas Tumulus), June 21, 1998.

Plot number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Estimated slope (°)	0	0	5	5	15	10	15	15	20	25	25	25	25	25	25	15
Estimated plant cover (%)	100	80	60	90	50	75	60	50	50	50	40	30	40	30	50	50
Plant taxon:																
Apiaceae																
Bupleurum	fl	(v)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eryngium	v/fl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asteraceae																
Artemisia	v	.	*v	*v	*v	v	*v	v	*v	.	.	.	.	.	.	v
Centaurea cf. *patula*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	fl	fl
Centaurea cf. *pseudoreflexa*	.	.	.	.	.	.	.	.	.	.	fl	.	.	.	fl	.
Centaurea cf. *virgata*	.	.	.	.	.	.	.	.	.	.	.	.	*fl	fl	.	.
cf. *Conyza*	*v/fl	v/fl	.	v/fl	.	.	.	.	.	.	.	.	.	.	.	.
Cousinia halysensis	v/fl	v	.	.	(v)	v/fl	.	.	.	.	.	.	.	.	.	.
Crepis (NM 2408)	fl	fl	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Koelpinea linearis	d	.	.	.	.	.	.	.	.	.	.	.	.	.	d	.
Matricaria/Anthemis	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. *Onopordum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	v/fl	.
Tragopogon dubius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	fr	.
Xeranthemum inapertum	*fl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NM 2344	fl	v/fl	.	v/fl	.	.	.	.	.	.	.	.	.	.	.	.
Boraginaceae																
Alkanna (NM 2378)	.	.	.	.	.	.	.	.	.	.	.	.	fr	.	.	.
Brassicaceae																
Alyssum cf. *blepharocarpum*	.	.	.	.	.	fl	.	.	fl	fl	.	.	fr	fl	.	.
Matthiola longipetala	.	.	.	.	.	.	.	.	.	fr	fr	.	.	.	.	.
Caryophyllaceae																
cf. *Bufonia*	.	.	.	.	(v)	.	.	(v)	.	.	.	.	.	.	.	.
cf. *Minuartia*	.	.	d	d	.	d	d	d	d	.	.	d	.	.	.	.
Petroraghia	.	.	.	fl	.	.	.	.	.	.	.	.	.	.	.	.
Silene (NM 2415)	.	.	.	.	.	d	.	.	.	.	.	.	.	.	.	fl/fr
Stellaria	fr	fr	.	fl	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodiaceae																
Krascheninnikovia ceratoides	.	.	.	.	v	.	.	.	v	.	v	.	.	.	v	.
cf. *Noaea mucronata*	.	fl	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Convolvulaceae																
Convolvulus lanatus	.	*fl/fr	(v)	(v)	.	.	.	.	.	.	.	.	.	.	.	.
Dipsacaceae																
Scabiosa	.	fl/fr	fl/fr	fl/fr	.	.	fl/fr	.	.	fl/fr	fl/fr	fl/fr	fl/fr	fl/fr	fl/fr	fl/fr
Euphorbiaceae																
Euphorbia (NM 2385)	.	d	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fabaceae																
Astragalus triradiatus	.	.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus cf. *lycius*	.	.	.	.	.	.	.	.	.	fr	.	fr	fr	.	.	.
Astragalus (NM 2377)	.	.	.	fr	.	.	.	.	.	fr	fr	fl/fr	.	fr	.	fr
Medicago constricta	fr	.	.	fr	.	.	.	fr	.	.	.	.	.	.	.	.
Onobrychis armena/oxydonta	.	.	.	.	fl	.	.	.	.	.	.	.	.	.	.	.
Trigonella astroites	fr	.	.	fr	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella coerulescens	.	.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella monantha	.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella cf. *pycnocephalus*	.	.	.	fl/fr	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella (NM 2410)	.	.	fl/fr	fr	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella (NM 1257)																
Geraniaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erodium cicutarium	fl	.	.	fl/fr	.	.	.	.	.	.	.	.	.	.	.	.
Illecebraceae																
Scleranthus	.	.	.	d	.	.	.	.	.	.	.	.	.	.	d	.
Lamiaceae																
Acinos rotundifolius	fl/fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scutellaria orientalis																
ssp. *pinnatifida*	.	.	.	.	fr	.	.	.	fr	.	.	.	.	.	.	.
Thymus (NM 1443) (small fl.)	.	.	.	.	*fl	*fl	*fl	*fl	*fl	*fl	*fl	*fl	fl	*fl	fl	.
Thymus (NM 2383) (large fl.)	.	.	fl	fl	.	fl	.	.	.	.	fl	.	fl	*fl	.	.
Ziziphora taurica	.	.	.	.	fl	fl	fl	fl	fl	fl	.	.	.	fl	fl	.
Papaveraceae																
Glaucium	.	.	.	.	.	.	.	.	.	fl/fr	fr	.	fr	.	.	fl
Hypecoum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	fr	.
Plumbaginaceae																
Acantholimon cf. *venustum*	.	.	.	.	fl	.	.	.	.	.	.	.	.	.	.	.
Ranunculaceae																
cf. *Delphinium*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	fl	.
Rubiaceae																
cf. *Asperula* (NM 2372/2401)	.	.	.	.	.	.	.	.	.	(v)	.	.	.	.	.	.

Table 3 continued

Plot number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Thymeleaceae																
Thymelaea cf. *passerina*	.	.	.	.	.	fr	.	fr	.	.	.	.	.	.	.	.
Zygophyllaceae																
Peganum harmala	.	v	v	v	*v	.	*v	.	.	.	.	.	.	.	.	.
Unknown families																
red parasite	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.
NM 2379 (sub-shrub)	.	.	.	.	.	v	.	.	.	fl	v	.	.	.	fr	fr
NM 2375 (<10 cm, herbaceous)	.	.	.	fr	.	.	.	.	.	.	.	.	.	.	.	.
Liliaceae																
Allium (NM 2380)	.	.	.	.	.	.	.	.	.	.	.	.	fl	.	fl	fl
Poaceae																
cf. *Agropyrum*	.	.	*fl/fr	fl/fr	.	.	.	.	.	.	.	.	.	.	.	.
cf. *Briza humilis*	.	.	.	.	.	fr	.	fr	.	.	.	.	fr	fr	fr	fr
Bromus cf. *cappadocicus* (NM 2358)	.	.	.	.	.	.	.	.	.	.	fr	*fr	.	.	fr	.
Bromus cf. *japonicus* (hairy)	.	.	.	fr	.	fr	.	.	.	.	.	.	.	.	.	.
Bromus cf. *japonicus* (glabrous)	.	.	.	.	.	fr	.	fr	fr	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	d	d	d	.	d	.	.	.	.	.	.	d	.
cf. *Bromus* (NM 2355)	.	*fr	.	.	.	fr	fr	.	.	.	.	.	.	.	.	.
Cynodon dactylon	*fl	*fl	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eremopyrum (NM 2381)	.	.	.	.	.	.	.	.	.	fr	fr	.	fr	fr	.	fr
Poa/Festuca	.	.	d	d	d	d	d	d	d	.	.	.	.	.	.	.
Stipa cf. *holosericea*	.	.	.	fr	.	.	.	.	.	.	.	.	.	fr	.	.
Stipa cf. *arabica*	.	.	.	.	.	.	.	.	.	fr	.	.	fr	.	.	.
NM 2365 = NM 2355?	.	.	.	fr	fr	.	.	.	.	.	.	.	.	.	.	.
NM 2368	.	.	.	d	.	d	.	.	.	.	.	d	.	.	.	.

v: vegetative only; fl: fruiting; fl: flowering; d: dry; +: present;* prominent in censused m^2; (v): uncertain designation (vegetative only). NM: N.F. Miller voucher specimen number.
Note: slope estimate: based on subjective impression and corrected by photograph (subjective impression was approximately double measured photograph, Plant cover estimate was also subjective, and should be viewed in relative terms.

Table 4. Plant taxa growing at base of Midas Mound*.

	Outside fence June 25, 1998	Inside fence June 18-24, 1998
N of taxa	33	42
N spiny or unpalatable	11	12
% spiny or unpalatable	33	29
Amaranthaceae		
Amaranthus	x	-
Apiaceae		
Bupleurum	-	x
•*Eryngium*	-	x
•cf. *Torilis*	-	x
Asteraceae		
Artemisia	x	x
•*Carduus nutans*	-	x
Centaurea pulchella	x	-
•*Centaurea solstitialis*	x	x
cf. *Conyza*	x	x
•*Cousinia halysensis*	-	x
Crepis	-	x
Koelpinia	-	x
+*Lactuca*	x	x
Matricaria/Anthemis	-	x
•cf. *Onopordum*	x	x
Xeranthemum inapertum	x	x
•NM 2426	x	x
Brassicaceae		
Alyssum	x	x
cf. *Sisymbrium loeselii*	-	x
Caryophyllaceae		
Stellaria	x	x
•cf. *Noaea mucronata*	x	-
Dipsacaceae		
Scabiosa	x	x
Euphorbiaceae		
+*Euphorbia*	x	x
Fabaceae		
•*Alhagi*	x	-
Astragalus lycius	-	x
Astragalus triradiatus	-	x

Table 4 continued

	Outside fence June 25, 1998	Inside fence June 18-24, 1998
Medicago constricta	x	x
•*Onobrychis*	x	-
Trigonella astroites	-	x
Trigonella coerulescens	x	-
Geraniaceae		
Erodium cicutarium	x	x
Lamiaceae		
Acinos rotundifolius	-	x
Thymus (NM 2383) (large fl.)	-	x
Papaveraceae		
Papaver cf. *hybrida*	x	-
Zygophyllaceae		
+*Peganum harmala*	x	x
Poaceae		
•*Aegilops* cf. *cylindrica*	x	x
•*Aegilops triuncialis*	x	-
cf. *Agropyrum*	x	x
Bromus japonicus (hairy)	x	x
B. japonicus (glabrous)	x	-
B. tectorum	x	x
Cynodon dactylon	x	x
Eremopyrum (NM 2381)	-	x
•*Hordeum murinum*	x	x
Phleum	x	x
Poa/Festuca	-	x
Stipa cf. *holosericea*	x	-
NM 2365	-	x
NM 2368	x	x
NM 2369	-	x
NM 2370	-	x
Unknown family		
NM 2375	x	x

Even when young, physically (with spines/hairs) (•) or chemically (+) unattractive to grazers, based on observation that animals seem to avoid these plants.
* census taken from circular plots of 1m^2 just inside and just outside Posts 3, 9, 15, 20, 26, and 30 (i.e., SW, NW, NE, E, SE, and S sectors).

project to the local museum staff, the gendarmes, and the villagers.

Finally, to ensure the long-term survival of plants on the Midas Tumulus surface we will continue monitoring the vegetation. It is possible that in the total absence of grazing, accumulating dry plant material might catch fire, as a natural phenomenon. In addition, there is no longer a source of animal droppings to fertilize the mound. This might adversely affect the 'natural' steppe vegetation, so within the next few years it may be desirable to allow some animals to graze under controlled conditions (e.g. five sheep for two or three weeks in the fall, after seeds have set but before the rains begin).

POTENTIAL APPLICATIONS

One of the most exciting aspects of the preservation work on the outside of the Midas Tumulus is that it has significance even beyond the successful stabilization of one of the major archaeological monuments of Turkey. Though a concern for environmental preservation is rapidly developing in Turkey, even in the United States the movement to restore native steppe vegetation has barely begun [15]. At Gordion, we have the opportunity to show how archaeologists can provide some solutions for a variety of problems.

Erosion control

The methods we are developing at Gordion should be applicable to many erosion problems. The methodology uses traditional Turkish technology in a new way, and is relatively inexpensive. It would be particularly applicable in regions where mudbrick is a traditional building material and foreign currency and expertise are hard to come by.

Biodiversity

A diverse flora is likely to be more stable in the long run. In addition, many of the native plants of central Anatolia have potentially important chemical compounds. Plant genetic research in Turkey (indeed, in the world) has just begun; this work will preserve important genetic resources.

Range management

The native steppe vegetation is naturally rich in edible pasture grasses and legumes. Overgrazing reduces the fodder plants and encourages the spiny and inedible plants. Our methods may begin to demonstrate the value and relative ease of restoring grazing lands by letting over-grazed pasture rest for a few years.

Ecotourism

Developing Gordion as a tourist destination can only be enhanced by treating the occupation mounds and tumuli as part of a modern cultural landscape that developed over centuries. Farming and herding are part of that landscape, but the natural flora and fauna are also of great value. Increasingly, tourists (both Turkish and foreign), will look for both cultural and natural attractions.

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