An Ancient Token System:

The Precursor to Numerals and Writing

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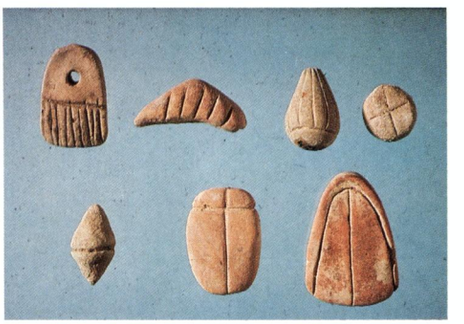
Writing began with the Sumerian civilization, which produced the first script sometime during the late fourth millennium B.C. As decisive as this development was for the course of human history, it was scarcely a sudden or spontaneous one. In fact, it was the outgrowth of several thousand years' worth of experience with a system for keeping track of commodities that depended upon counters—tokens modeled from clay into varying shapes. These ancient reckoning devices gave rise not only to writing but to numbers as well. Their story is a fascinating instance of the ways in which human cognition evolved.

Not one but two traditions can be traced in the development of the ancient use of tokens. The earlier arose in the eighth millennium B.C. in conjunction with the birth of sedentary agriculture; it is a distinctly agrarian tradition in its geographical spread as well as its economic function, which was principally keeping track of agricultural commodities, grain in particular. This first tradition gave rise to simple tokens, as we will call them here: these were simple geometric forms with plain, unmarked surfaces such as spheres, flat and lenticular disks, cones, tetrahedrons, and cylinders. These forms seem arbitrary in shape, the result of a concern for making shapes easy to identify and duplicate with the least possible effort.

The second tradition, in contrast, which gave rise to complex tokens, appeared with the first cities, and is one of the first indications of urbanization. These tokens are of similar manufacture to the plain ones, but differ in representing a greater repertory of shapes and in bearing various kinds of markings on their surfaces. Complex tokens, as we will call them, belong to the latter part of the fourth millennium B.C., and must be strongly associated with the rise of the Sumerian temple institution, which is commonly regarded as the origin of state formation in the ancient world.

Since complex tokens arose with the first cities, their geographic distribution is naturally more limited than that of the simple tokens. On the other hand, their sheer variety attests to the fact that they were used to denote a much wider range of commodities than the simple tokens. Biconoids, ovoids, bent coils, rhomboids, parabolae, quadrangles—such are some of the geometric forms of the complex tokens. They also occur as miniature representations of tools and utensils, containers and animals, such as a series of small vessels,

Prior to the invention of Sumerian writing, accounting was practiced in the ancient Middle East by means of small clay counters called tokens. Plain tokens **(above, left)** ***are characterized by simple geometric shapes and surfaces devoid of markings, such as these from Tepe Gawra which average two centimeters in height.*** **(Above, right)** ***The application of markings to these tokens from Susa is a distinctive feature of the more diversified complex tokens.*** **(Above)** ***This complex token from Tello represents a trussed duck.***



Complex tokens typical of the late fourth millennium B.C. include such shapes as parabolae, triangles, ovoids, biconoids, and quadrangles.

Some complex tokens were perforated in order to be strung together.

forms which required a certain skill for their manufacture. As we will see shortly, complex tokens also used surface markings profusely.

These two traditions were intimately related, the latter growing directly out of the former. In some cases the complex tokens are nothing more than simple ones bearing markings on their surfaces. Again, both kinds are of similar manufacture, both being fired at low temperatures, around 600 C., and share in size, material and color as well as in most shapes. Both types, moreover, occur in the same hoards.

Both plain and complex tokens of the fourth millennium B.C. were sometimes kept together in groups, though the normal means for this differed. The plain tokens were generally enclosed in a clay envelope, whose exterior bore seals and markings indicating what was enclosed. As we will see shortly, these external markings had profound implications for the subsequent history of writing. The complex tokens, in contrast, were kept together in a somewhat more elaborate fashion: instead of being encased in a clay envelope, they were perforated and eventually strung together on a string that was attached to an oblong *bulla*—a solid oblong blob of clay bearing sealings, and displaying at either end the imprint of the string. What resulted was an almost bead-like arrangement in which the seals on the *bulla* served to identify the accounts in question.

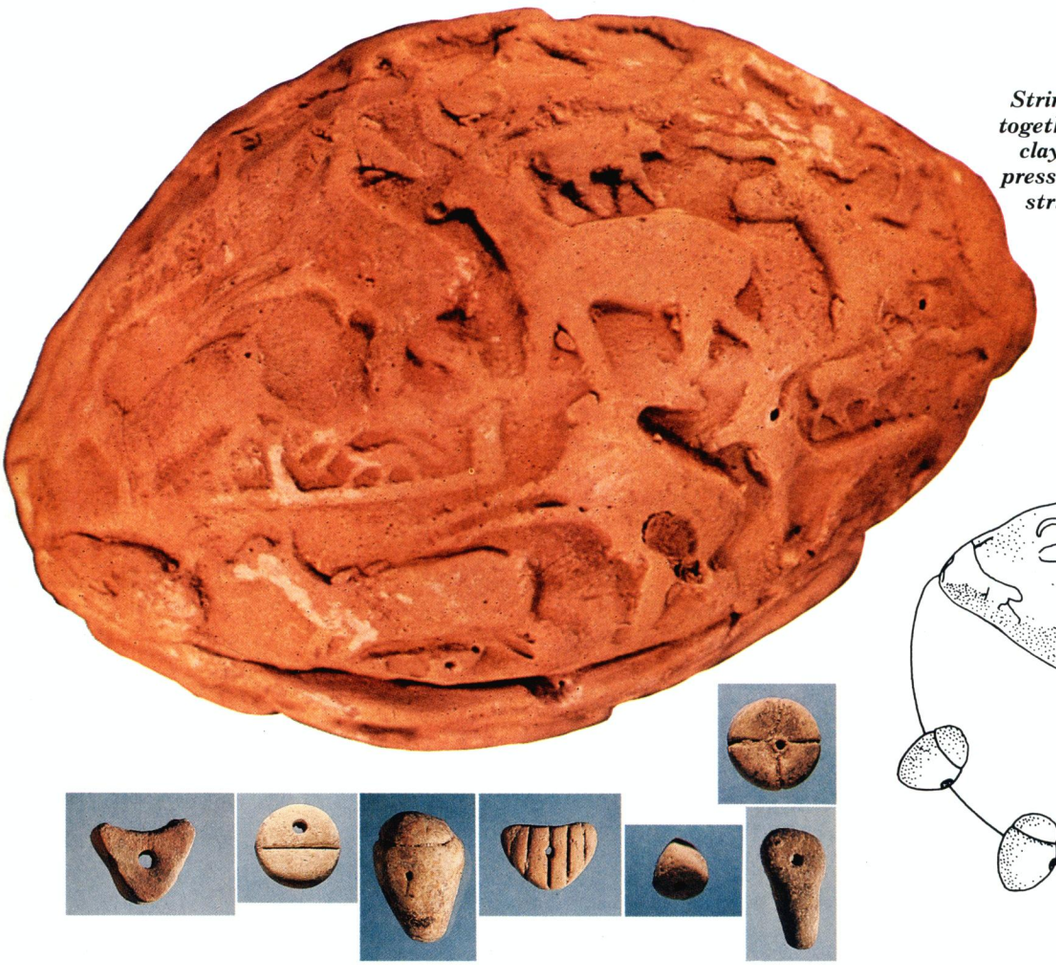
The clay envelopes and *bulla* were not only made of the same material and held similar sealings, but they also sometimes bore the impression of the same seal. In addition, while each is associated with different kinds of tokens, the two types of tokens were frequently mixed—plain tokens were sometimes perforated, and complex ones were sometimes kept in envelopes. So the two types of storage could intermix.

How do we interpret these ancient reckoning tokens, and where do they come from? We must answer these questions before we see how these related traditions gave rise to numbering and writing.

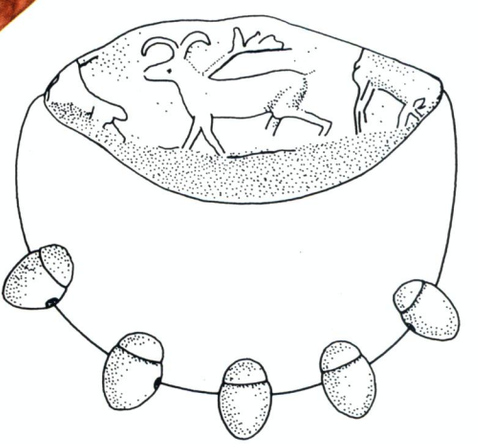
The earliest assemblages of plain tokens have been recovered in the remains of villages of the Fertile Crescent dating 8000-7500 B.C. These villages have a number of characteristics in common: they consisted of round huts typical of the transitional period between a hunting-gathering and a farming economy which relied on the consumption of grain; and they showed no obvious signs of animal domestication. The presence of obsidian at most of these sites, moreover, attests to their participation in a trade network.

Of the very earliest of such sites, Tell Aswad I, Tell Mureybet III and Cheikh Hassan in Syria were fully sedentary settlements and show direct evidence for the cultivation of cereals. On the other hand, Tepe Asiab and Ganj Dareh Tepe E in Iran were perhaps no more than semi-permanent encampments of hunters and gatherers. The first occurrence of tokens at Tell Mureybet, which is particularly revealing, takes place only in the third level of occupation of the site—the first occupation level during which the village was functioning as an agricultural community. A number of new features coincide at Tell Mureybet III with the appearance of simple tokens. First, a quantum jump occurs in the quantity of cereal pollen in the soil, the first evidence for the cultivation of grain in the fields around the site. In addition, rectangular storage silos are in evidence; and there is a substantial increase in the population, which argues for the emergence of a new social structure.

From these important new features, we can deduce that the invention of record-keeping in the ancient Middle East appears to have little to



Strings of complex tokens were held together by an oblong **bulla**, *a blob of clay which bore identifying seal impressions. A reconstruction of such a string* (**below**) *illustrates what this may have looked like.*



do with animal domestication and herding, since there is no evidence for herding in the sites where tokens first occur. Nor, for that matter, is there any convincing correlation with trade. Instead the need for counting and accounting seems to be related in that part of the world to an economy based on the cultivating and hoarding of cereals, and the socioeconomic changes that followed the birth of agriculture. It seems logical that an economy involving the planning of subsistence over the seasons would both incite and require a feasible record-keeping system.

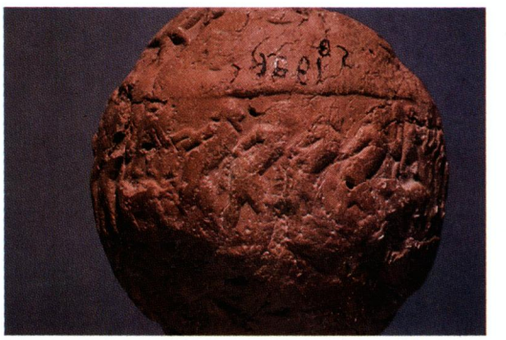
This system was destined to persist quite unchanged for the better part of four millennia, and it can be seen to have spread over a large geographical area stretching from Anatolia to Palestine and from Syria to Iran. Indeed, plain tokens became ubiquitous to this region, and appear in all possible settings—cities, towns, villages, and even cave dwellings. From settlement to settlement, moreover, these plain tokens vary only in number: some sites produce only a handful of them, whereas others have yielded several hundred. In the case of Jarmo, Iraq, there were more than a thousand of them.

How, more precisely, were the simple tokens actually used? Like complex tokens, the plain ones were part of a mnemonic device used to organize and store economic data. Representing units of real goods in a one-to-one correspondence, these counters were doubtless lined up in front of accountants who organized them according to types of goods, producers or recipients, entries or expenditures, or any other criteria. Furthermore, the tokens could be arranged into visual patterns facilitating the estimation and counting of quantities of items at a glance. While the earliest use of simple tokens seems to have been solely for agricultural products, this would gradually diversify to include other products, such as storage vessels.

Such tokens also offered a means of reliable data storage, since sets of counters enclosed in clay envelopes could serve as permanent records for transactions to be completed in the future, as well as ones that had just been transacted. This seems to be the case for groups of tokens found enclosed in envelopes—really, hollow globular cases—covered with seal impressions. Such impressions most likely represented formal agreements—I.O.U.s—kept in temple archives of the fourth millennium B.C. Despite the relative lateness in date of such envelopes, they predominantly held plain tokens and rarely complex ones, a fact which would argue for the distinctly different uses to which plain and complex tokens were normally put.

Whereas simple tokens are found in and refer to the commodities of agricultural communities, complex tokens not only arise in urban centers, but also quite clearly pertain to the products of urban workshops. Moreover, as we shall see, complex tokens constitute a much more complicated accounting system by virtue of their varying shapes and the extraordinarily wide range of markings which they bear. The evidence also indicates that plain and complex tokens were managed by different sets of hands within the Sumerian temple administration, the plain tokens belonging to the pens and granaries whereas the complex sort pertained to workshops. Indeed, complex tokens clearly seem to be associated with the world's first system of coercive taxation and redistribution of goods.

Essentially a southern Mesopotamian phenomenon, complex tokens



Plain tokens were kept in temple archives in globular clay envelopes. These envelopes were marked with seals and markings to indicate what was enclosed.

have, as we said earlier, a more limited geographical distribution than simple ones. None have so far been recovered in either Turkey or Palestine, and they extend only sporadically to sites in the north. In the east, they are found no farther than the adjacent Susiana Plain; and they extend only to rare sites along the Euphrates River toward the west. In southern Mesopotamia complex tokens were used in Uruk, Girsu, Ur, Nippur, and Ubaid. In northern Mesopotamia (Iraq), Tell Billa has a few, but Tepe Gawra none. In Susiana, the only sites which yield any are Susa, Chogha Mish, Moussian, and KS 54. In Syria, complex tokens are included in the assemblages of Habuba Kabira, Tell Kannas and Jebel Aruda. There are also vast differences in the number of complex tokens recovered at each of these sites, which may not reflect only the archaeologist's luck. The main metropolises of Uruk and Susa, for example, each yielded large assemblages of about 800 tokens each, compared to a single example at Ubaid or Jebel Aruda.

Complex tokens can best be documented in their first occurrence in the Sumerian metropolis of Uruk. There, the earliest group was recovered in the ruins of Eanna, the major temple precinct dedicated to the goddess of love, Inanna. They belonged to level VI of the temple, dated to about 3350 B.C., which is also the level when buildings decorated with colorful clay cone mosaics are introduced into the precinct. It is particularly significant that complex tokens coincide with these architectural features, because the latter afford us evidence for the first monumental public buildings, which, in turn, mark the inception of Eanna as a predominant economic institution in the ancient Middle East.

Sumerian art of the period offers insight into the economic workings of society at this time. For the period between 3350–3100 B.C., corresponding to levels VI–IV, we discover that the economy implemented by the Sumerian temple was based on the pooling together, the management and the redistribution of a surplus produced by the community. Art from the period represents processions of individuals delivering their dues to the temple in the form of goods in kind. The chief administrators or *En* are often seen leading the procession, and are recognizable by such status symbols as a beard, a special headdress and a long garment. Levels VI–IV are also characterized by a profusion of typical vessels such as beveled-rim bowls and nose-lugged jars, which are believed to have served as measures for the delivery of dues to the temple. The increased use of seals during this period —in particular, the important introduction of cylinder seals—also indicates a strengthening of administrative control.

Three characteristics, then, stand out among the sites which produced complex tokens: clay cone mosaics for the decoration of public buildings; specific types of pottery vessels; and cylinder seals, often bearing such motifs as the *En* in typical attire. These features, all of which are characteristic of Eanna levels VI-IV, constituted a foreign intrusion into Susiana, Syria and northern Mesopotamia. The distribution of complex tokens seems, therefore, to identify centers directly under the influence of the Sumerian temple.

Interestingly, the artwork on the cylinder seals from the period indicates that tribute was not always willingly paid to the authorities. Some of the carvings show the *En* presiding over scenes of punishment, such as

beatings probably inflicted on the first tax delinquents. From this perspective, the quantum jump in the number of token shapes coincides with the establishment of a coercive redistributive economy. We are speaking, here, about the imposition of taxation, whose implementation required both authority and administration as well as a system of measures and precise reckonings. Such administrative control would also require large storage facilities and stiff penalties for noncompliance.

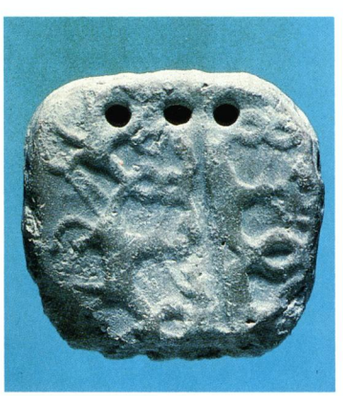
Complex tokens do not appear suddenly and without precedent with the rise of urban civilization; it should be emphasized here that tokens bearing simple markings of one or two strokes or notches were already present in the earliest token assemblages of the early eighth millennium B.C. Such tokens, however, remained exceedingly rare until a remarkable increase occurred in the number and variety of markings and in the number of different shapes which became characteristic of complex tokens. At the same time, it should also be well understood that plain tokens continued to exist unchanged throughout the fourth millennium, coexisting with the complex shapes.

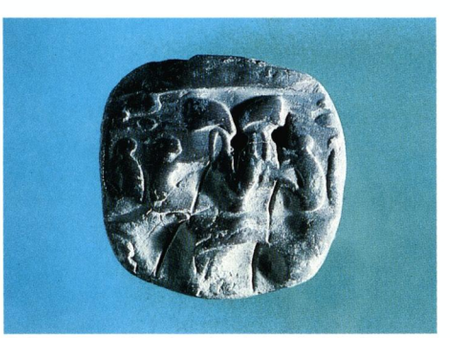
From their first appearance on, complex tokens show evidence of being held together by strings of the sort mentioned earlier in conjunction with the *bullae.* Sixteen percent of the counters recovered at Uruk and 55 percent of those found at Susa were perforated. The major differences, however, in the appearance of the two types of token refer to their shape and, most important, to the markings they bear. A study of the cuneiform and ideographic signs of the second and third millennia B.C. for cereals and domesticated animals —the two traditional staples of the ancient Middle East—point to plain tokens as their progenitors. Cones and spheres, specifically, referred to the two most common Sumerian grain measures, the *ban* and the *bariga,* approximately equivalent to our liter and bushel. Large cones, large spheres and flat disks were used to designate larger-capacity units of grain. In addition, cylinders and lenticular disks were used as units of animal count, the cylinder standing for one and the lenticular disk for a collection of animals—"a flock" —perhaps of ten.

Complex tokens also find counterparts among Sumerian pictographs indicating animals, but in this case, they convey more than a mere generic reference, and refer even more explicitly to the sex and age of the creatures: such disks with various patterns stand, for example, for "one male sheep," "one ewe," and "one lamb." More typically, however, complex tokens can be matched with signs representing finished products—as we said earlier, the products of the workshop. Incised cones, ovoids and rhomboids, for example, represented processed foods such as bread, oil and beer. Biconoids and triangles indicate luxury goods such as perfume and metal.

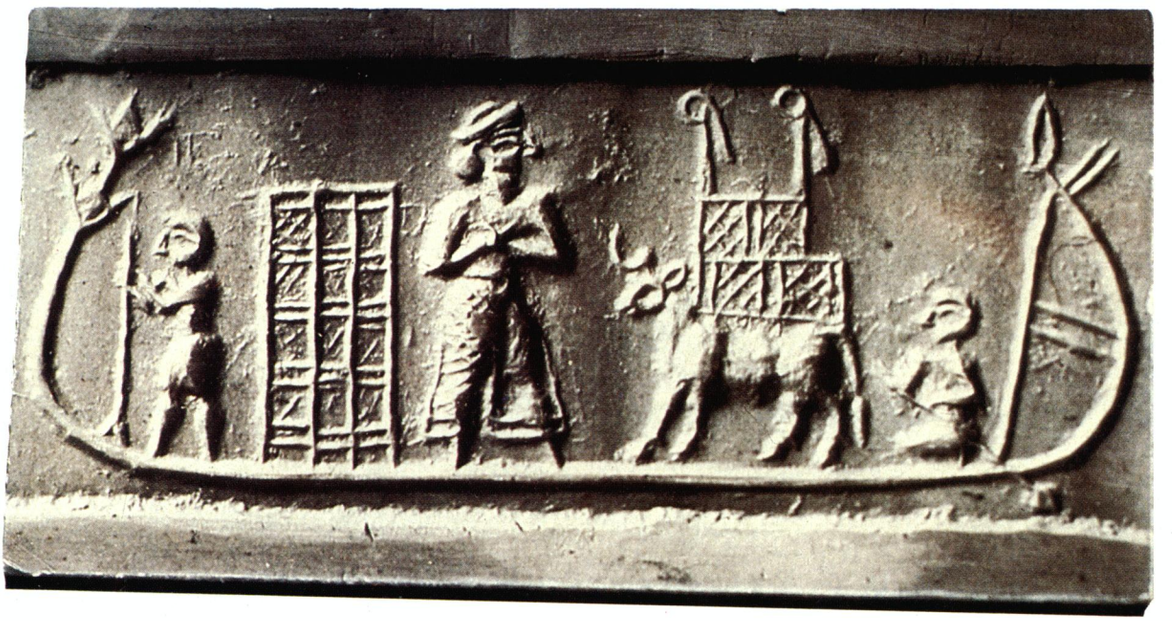
The introduction of cylinder seals is evidence of the strengthening of the administration. This carving represents the* En*, or chief administrator, recognizable by such status symbols as a beard, a special headdress and a long garment.

There is also a series of tokens which seem particularly significant because they refer to items of the textile industry, which was very important in the early Mesopotamian temple economy. Among them are





(Far left) ***Plain tokens were replaced by markings made of their negative imprint on a clay tablet. Like the former tokens, the impressed signs continued to show the number of items by repeating the marking.*** **(Left, middle)** ***A unique tablet from Susa displays a composite impressed-incised technique with incised markings applied over the impression of spheres and triangles. Height, 5.7 centimeters.*** **(Left)** ***Complex tokens were perpetuated in the Sumerian writing system by signs traced with a stylus. This example from Godin Tepe, a pictograph for a jar of oil, is preceded by numerals—special signs expressing a number. Circular and wedge-shaped signs came to signify "ten" and "one."***



several series of disks and parabolae with linear markings which signify types of fibers, cloths and garments, whereas incised cylinders and rectangles stand for strings and mats. Finally, examples of naturalistic tokens clearly represented further processed foods such as trussed ducks as well as manufactured products such as tools, weapons, pieces of furniture, and a variety of vessels.

All of this evidence, taken together, indicates that the token system was used solely for the keeping of records on commodities throughout its entire lifetime, regardless of whether the tokens were simple or complex ones. That the two kinds were handled by different methods of storage in the temple archives can be explained by the fact that one group belonged to the pens and granaries, whereas the other served the workshops.

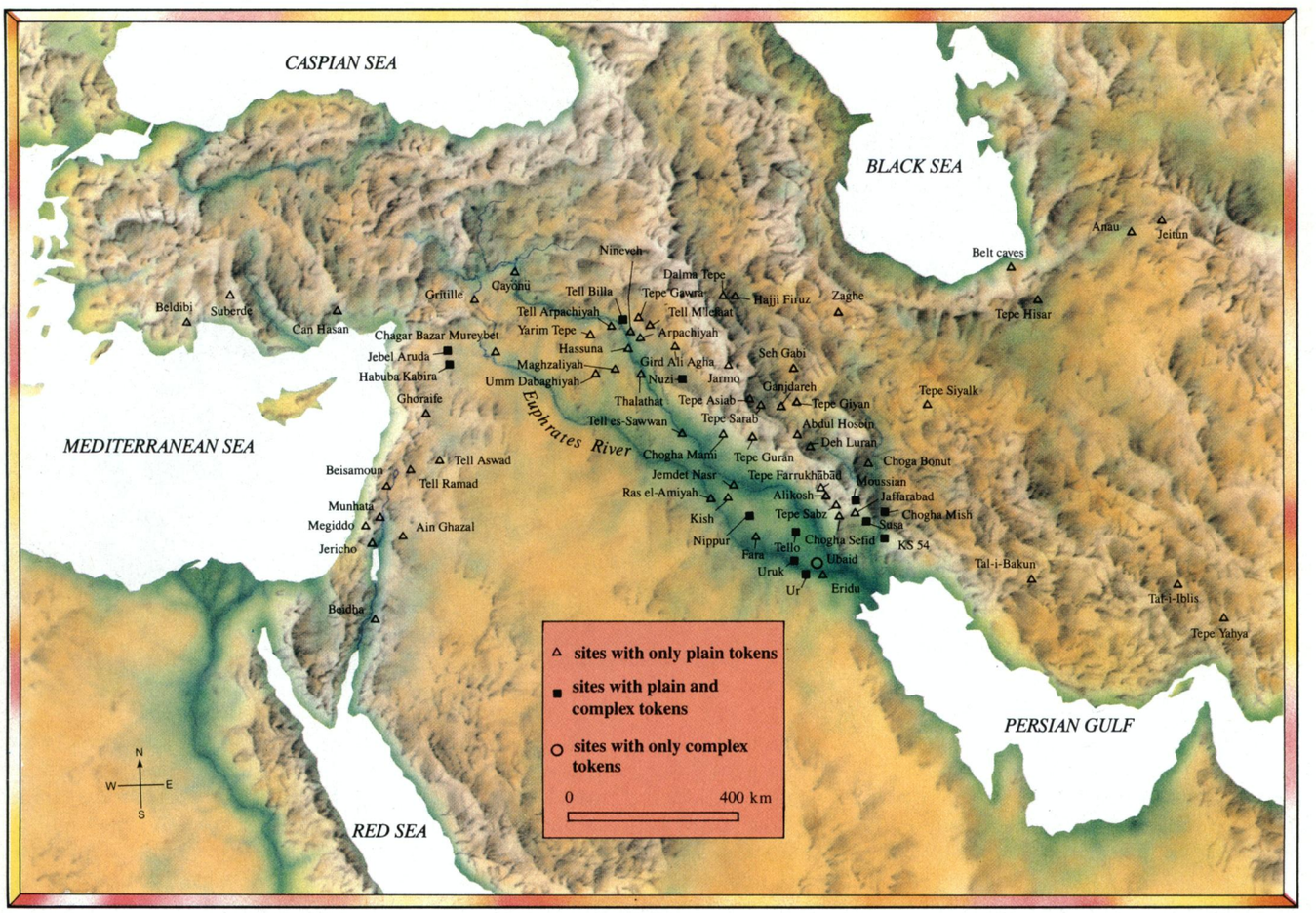
We can now approach the question of how these two types of tokens gave rise to two kinds of signs. We might note, though, before we begin, that the system we use today has two categories of signs: our numerals are ideographs and our letters are phonetic signs, a distinction presaged in the first reckoning system that used tokens.

We should also note, initially, that abstract numbers must be accorded their place among the greatest of human contrivances; too frequently in studies of the development of mathematics, the invention of zero and the advent of place notation have been heralded as major accomplishments of the civilized world while abstract numbers have mistakenly been regarded as intuitive. This is simply not the case; and the token system is just one piece of artifactual evidence which proves that counting, like anything else, was not spontaneous but a product of long, slow cultural evolution. Indeed, two steps can be identified in the evolution of counting in the ancient Middle East. The first, called "concrete counting" preceded the use of abstract numbers. This stage is illustrated by the use of tokens. It is characterized by two main features: tokens were used in one-to-one correspondence with the commodities they represented, and each commodity necessitated a particular counter to be counted. The second major step is marked by the introduction of abstract numerals, which occurred when impressed signs indicating standard measures of grain came to represent not grain or any other specific commodity, but the *concept* of pure quantity. The extraordinary invention of abstract numerals amounted to a revolution in both accounting and human communication since it provided, for the first time, a reckoning system applicable to any and every item under the sun. This decisive development of the concepts of oneness, twoness and so forth put to an end the cumbersome system necessitating particular symbols for counting different types of goods.

What initially separated writing from counting? How did the technique of writing evolve? And in particular, how did numerals come about? To begin with, plain tokens, contained as they were in clay envelopes, were hidden from view. This problem led clerks to mark the surface of the envelopes by impressing each token on the outside of the envelope prior to closing it; thus making visible the number and shapes of the tokens included. The marked envelope, in turn, soon led to a further improvement—the devising of solid clay tablets in the form of a small cushion bearing token impressions. In other words, plain tokens were replaced by markings consisting of their negative imprint on a clay tablet.

The repertory of impressed markings which we find on envelopes as well as on tablets is limited to a dozen signs, eight of them deriving from plain tokens. They include circular markings of various diameter and depth, standing for the former small and large spheres, the flat and lenticular disks. They also consist of wedges of different length and width corresponding to the former cylinders, cones and large cones.

Impressed markings of this sort were destined to give rise to numerals. They contrast decisively with the sorts of markings that derive from complex tokens, which were destined to give rise to the other signs of



writing, precursors to letters. Complex tokens were marked with linear patterns, notches and punctuations that were traced or impressed with a stylus; rare examples of appliqué pellet also occur. The merging of complex tokens with writing was different by virtue of the simple facts that complex tokens were not generally held in envelopes, and that one could not readily impress a complex token on a clay tablet and get a sharp, decipherable image. Complex tokens were therefore perpetuated on the tablets by means of signs written with a stylus—a technique that is scarcely surprising, since it made use of the same pointed stylus that was used to trace the markings on their face to begin with.

These are developments which are reflected in the evolution of the Sumerian script, where plain tokens and their impressed images give rise to numerals, whereas the incised signs on complex tokens, indicating as they did the nature of the items counted, gave rise, again, to the remaining signs of writing. We must not assume, however, that these two traditions developed without any overlap; interestingly enough, tetrahedrons—one of the most frequent of plain tokens—seem to have given rise to an incised pictograph; inversely, there are examples of incised ovoids being impressed on at least two envelopes. Finally, there is a unique tablet displaying a composite impressed-incised technique: here, incised markings have been applied over the impressions of spheres and triangles.

In any event, the new system of notations was infinitely more practical than the cumbersome older one since the clay tablets with their neatly aligned signs were far less unwieldy than the loose tokens, even those contained in clay envelopes. The new system was also more expedient since either impressing or tracing markings with a stylus was quicker than the process of modeling each individual token. The new method was so satisfactory that tablets remained in continuous use throughout the next three millennia in the ancient Middle East, to be displaced only when the Aramaic script, written with a flowing hand on papyrus, provided an even more efficient method for handling information.

We must see more precisely, now, how impressed and incised markings expressed quantities in different ways. Like the tokens, initially, the impressed signs continued to indicate the number of items counted by repeating the marking in one-to-one correspondence: one, two or three small measures of grain were indicated by one, two or three small wedges; and one, two or three bushels of grain were indicated by one, two or three circular markings.

These tokens from Susa were made from the negative imprint of a plain token on a clay tablet. Spheres were shown by circular markings and cones by wedges. These tokens represent (counterclockwise from center) *a grain account, animal account, another animal account, grain account, and one more animal account.*

On the other hand—and quite importantly—incised signs are never found in repeated one-to-one correspondence. Thirty-three jars of oil, for instance, were no longer expressed by showing the sign for oil repeated 33 times; instead, the pictograph for "jar of oil" was preceded by numerals—special signs expressing a number. In fact, the new signs used to express abstract numbers were nothing other than the impressed signs for measures of grain used in a novel fashion. An impressed wedge and an impressed circular sign standing for a small and large measure of grain respectively also came to signify "one" and "ten." Such dual usage may seem confusing to us, but it seems not to have been a problem for the ancient clerks, who could determine from the context which reading was appropriate. The system of using identical signs for numbers, in fact, was perpetuated throughout the Sumerian period without causing any apparent confusion among scribes.

The use of impressed signs as numbers did not detach itself immediately from the traditional one-to-one correspondence, just as other changes in the token system had been slow in coming. Since oneness, twoness, threeness, and so forth were expressed by one, two, three wedges, and so forth, and since ten, 20 and 30 were expressed by one, two and three circular signs, we can see that the transition to a purely abstract system of enumeration was a gradual one. The invention of abstract numerals resulted in a tremendous economy of notation, of course, since ten wedges would be replaced by a single sign for ten. As a result, for example, ten jars of oil could be shown by two signs only: "ten" and "jar of oil."

The original duality of the token system resulted in a split that grew ever wider with the invention of writing as the system evolved in the direction of abstract numbers. Both traditions, however—that of simple tokens and that of complex tokens—made powerful contributions to the world's record-keeping abilities, and to humanity's capacity for efficient, reliable communication. This story is, in essence, a study in the stages whereby human culture slowly, and then ever more quickly, mastered the art of abstraction, which stands as one of the peculiar marks of distinctive human consciousness. □

Sumerians deliver offers to the temple. (Left) *The* En, *or chief administrator, characterizes a more complex administration.*