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PART ONE

THIRD AND SECOND MILLENNIUM B.C.

From Counting to Writing: The Quest for Abstraction

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The development of civilization – the stage of cultural development at which writing is attained – required the acquisition of complex cognitive processes such as abstraction. In this paper I analyze the development of the capacity of abstraction in the ancient Near East between 7500–3000 BC as reflected by tokens and writing.

COUNTING AND THE REDISTRIBUTION ECONOMY IN THE ANCIENT NEAR EAST

In the ancient Near East, agriculture was associated with the formation of a redistribution economy. Based on studies of modern archaic societies and of the pre- and proto-historic Near East, it can be assumed that the Neolithic community leaders collected at regular intervals a share of the farmers' flocks and harvests. In turn, the accumulated communal goods were redistributed for the benefit of the group. Some were allocated to those who could not support themselves, but the greatest part was earmarked for the performance of rituals and festivals in honor of the gods. In other words, with agriculture came the need for counting and accounting in order to control and manage community surpluses.

Before analyzing their cognitive significance, I briefly describe tokens and writing, the two accounting systems created to compute entries and expenditures of goods in kind during the first four millennia of the Near Eastern redistribution economy. The earliest system with tokens appeared about 7500 BC. It consisted of counters, about 1–2 cm across, modeled in clay in multiple, often geometric shapes such as cones, spheres, disks, cylinders, tetrahedrons, ovoids, triangles, and quadrangles (Figure 1). Some

of them bore markings in the form of incised lines and impressed dots. In 7000 BC, because the system exclusively recorded goods, there were only some ten token shapes, each representing one of the farm products levied at the time, such as grain, oil and domesticated animals.

The prehistoric administration used tokens to record three types of information. The shape and markings of the artifacts indicated first, the type of good computed, and second, the quantity thereof. For example, both the cone and the sphere stood for grain but in two different quantities probably equivalent to a "small" and a "large" basket of grain, and an ovoid with a circular incision represented a jar of oil. It should be well understood that, at the time, measures were not yet calibrated. They consisted of the traditional containers used to handle goods in everyday life, such as different-sized baskets, jars, juglets, bowls or cups. It is even conceivable that the tokens represented such casual units as an "armful" or a "handful." The system, therefore, only dealt with approximate quantities comparable to today's "carafe" of wine or "cup" of coffee. Lastly, the tokens recorded the number of units of goods received or dispensed in one-to-one correspondence. In other words, two small units of grain were shown with two cones, three cones stood for three small units of grain, and so on.

There can be no doubt that an unceasing cross-fertilization took place between the economy's increasing demands and the development of counting and accounting. For example, the number of token shapes increased to about 350 around 3500 BC, when urban workshops started contributing to the redistribution economy. Some of the new tokens stood for raw materials such as wool and metal, and others for finished products including textiles, garments, jewelry, bread, beer, and honey (Figure 2). These so-called "complex" tokens sometimes assumed the shapes of the items they symbolized such as garments, miniature vessels, tools, and furniture. These artifacts took far more skill to model compared to the former geometric shapes such as cones and spheres, suggesting that specialists were then manufacturing them (Schmandt-Besserat 1992).

By 3300 BC, tokens were still the only accounting device to run the redistribution economy now administered at the temple by priestly rulers. The communal offerings in kind continued but the types of goods, their amount and the frequency of delivery to the temple became regulated, which meant that noncompliance was penalized. The response to the new challenge was the invention of envelopes where tokens representing a delinquent account could be kept safely until the debt was paid. The tokens standing for the amounts due were placed in hollow clay balls and, in order to show the content of the envelopes, the accountants created markings by impressing the tokens on the wet clay surface before enclosing them (Figure 3). The cones and spheres symbolizing the

measures of grain became wedge-shaped and circular impressed signs (Figure 4). Within a century, about 3200 BC, the envelopes filled with counters and their corresponding signs were replaced by solid clay tablets, which continued the system of signs impressed with tokens. By innovating a new way of keeping records of goods with signs, the envelopes created the bridge between tokens and writing.

With the formation of city-states, ca. 3200–3100 BC, the redistribution economy reached a regional scale. The unprecedented volume of goods to administer challenged writing to evolve in form, content, and, as will be discussed later, in cognitive ability. First, about 3100 BC, the form of the signs changed with the use of a pointed stylus that sketched more accurately the shape of the most intricate tokens and their particular markings. The sign for oil, for example, clearly reproduced the ovoid token with a circular line (Figure 5).

Second, plurality was no longer indicated by one-to-one correspondence. Numbers of jars of oil were not shown by repeating the sign for "jar of oil" as many times as the number of units to record. The sign for jar of oil was preceded by numerals—signs indicating numbers. Surprisingly, no new signs were created to symbolize the numerals but the impressed signs for grain took on a numerical value. The wedge that formerly represented a small measure of grain came to mean "1" and the circular sign, formerly representing a large measure of grain meant "10."

Third, about 3000 BC, the state bureaucracy required that the names of the recipients or donors of the goods listed be entered on the tablets. And to record the personal name of these individuals, new signs were created that stood for sounds—phonograms. The phonograms were sketches of things easy to draw that stood for the sound of the word they evoked. The syllables or words composing an individual's name were written like a rebus. The drawing of a man stood for the sound "lu" and that of the mouth for "ka," that were the sounds of the words for "man" and "mouth" in the Sumerian language. For example, the modern name Lucas, could have been written with the two signs mentioned above "lu-ka" (Figure 6).

The state administration could no longer deal with the approximate quantities of informal containers and this prompted the standardization of measures. The resulting adjustment in accounting was to assign new signs for the standard measures of grains (*ban*, *bariga*, etc.), liquids (*sila*), and surface areas (*ikus*, *eše3*, *bur*, etc.). The standardization of measures brought accounting to an unprecedented precision, while putting an end to dealing with informal hand-manufactured containers (Figure 7).

During four millennia and a half, from 7500 to 3000 BC, tokens and writing constituted the backbone of the Near Eastern redistribution economy. Both recording

systems were closely related in material, form, and function. They shared clay as a raw material; the token shapes were perpetuated by the written signs; and both kept track of similar quantities of the same types of agricultural and industrial goods for an identical socio-economic function. The difference between the systems was cognitive, namely the degree of abstraction used to manipulate data.

TOKENS AND ABSTRACTION

The cognitive principle at work in the token system was abstraction—i.e. the dissociation of one feature from a collection. Each token abstracted goods in two ways. First, their shape abstracted one of the types of merchandise levied; for example animals, grain, or oil. Second, the shape abstracted the quantity of merchandise. The cone abstracted the unit corresponding to a small basket vs. the sphere that abstracted a large basket.

Otherwise the token system remained concrete in form, content and in the representation of plurality (Malafouris 2010).

- The tokens were solid and tangible artifacts. They could be grasped with the fingers and held in the hand.
- Each token stood for a concrete entity, namely, one unit of staple goods. Note that an ovoid token stood for a "jar of oil," and a sphere for a "large basket of grain" which means that, as in daily life, the product (oil, grain) and their usual container (jar, basket), were fused into a single concept.
- The token system dealt with plurality concretely, in one-to-one correspondence—as it is in the real world. In nature, a forest consists of a multitude of single trees; a flock is a set of single animals.

TOKENS AND COGNITION

The true cognitive significance of the token system was to foster the manipulation of data. Compared to oral information passed on from one individual to the other, tokens were extra-somatic, that is outside the human mind. As a result, the Neolithic accountants were no longer the passive recipients of someone else's knowledge, but they took an active part in encoding and decoding data.

The token system substituted miniature counters for the real goods, which eliminated

their bulk and weight and allowed dealing with them in abstraction. As a result, heavy baskets of grains and animals difficult to control could be easily counted and recounted. The accountants could add, subtract, multiply, and divide by manually moving and removing counters.

Patterning, the presentation of data in particular configurations, also promoted the abstraction of particular features. For example, the tokens representing the budget for a festival could be ordered in columns abstracting the merchandise according to its types, donors, entries and expenditures, and intended use, i.e. for particular rituals. The relative value of merchandise could be abstracted by lining up units of greater value above those of lesser value. For instance, spheres standing for large measures of grain could be placed above the cones, representing small measures of grain. It is well possible that the geometric lay out of operations such as adding two tokens to two tokens, and three tokens to three tokens, and so on, helped the conceptualization of abstract numbers (Justus 1999: 56, 64; Hoyrup 1994: 70)

Finally, because the clay tokens could be manufactured at will and stored indefinitely they abstracted goods from time. Consequently, accountants could manage merchandise independently of their current status. For instance, quantities of grain could be accounted for whether they were still in the fields or harvested, stored in granaries or in transit, delivered or promised.

In sum, the immense value of the token system was in promoting the acquisition of new cognitive skills that capitalized upon the visualization and physical manipulation of data. Computing with tokens in ever-greater volume of more complex data paved the way to writing.

WRITING AND ABSTRACTION

Archaeology can interpret the technological innovations of the token system, such as the creation of new shapes and envelopes. But the cognitive dynamics that led writing to create logograms, numerals, standard units of measure, and phonograms are far beyond the scope of traditional archaeology. These remarkable leaps in abstraction can be identified and dated to the early fourth millennium BC but their interpretation will have to wait until cognitive archaeology comes of age (Malafouris 2010).

The early logograms, i.e. signs in the form of tokens standing for a unit of merchandise, represented a second degree of abstraction. The signs impressed or traced with a stylus, abstracted tokens, which were themselves abstracting actual goods.

A circular marking replaced the round token, which means that the written signs kept the outline of the counters and their symbolic significance but did away with their volume. Intangible written signs replaced the awkward piles of three-dimensional tokens.

Written numerals abstracted the common denominator between sets such as three baskets of grain and three jars of oil. As a result, "three" became a concept that could be expressed by a sign. The invention of abstract numerals had extraordinary consequences. First, it put to an end dealing with goods in one-to-one correspondence. Second, numeral signs made obsolete the use of different counters or numerations (different number words) to count different products. Finally, with the abstraction of numbers counting had no limit.

About 3000 BC the abstraction of numbers (how many) was followed by that of quantity (how much). Thereafter, writing abstracted each of the concepts involved in, for instance, "one" "sila" of "oil," requiring a sequence of three signs for notation. Instead, a century earlier in 3100 BC, two signs were sufficient to record a similar amount, namely, "one" "jar of oil," and in 3500 BC, a single token fused the three concepts together, "one jar of oil."

Finally, the invention of phonograms, that abstracted the sounds of speech, removed writing from the concrete world of real goods. The signs no longer referred to concrete objects, but instead to the sound of a word. This was the beginning of a phonetic script when, by emulating speech, writing was no longer confined to the recording of goods.

Of course, all these processes of abstraction innovated by writing, in particular that of numbers, were to take many steps to be fully realized (Justus 1999a). It is clear that for many centuries the commodity counted still determined the arithmetical value of numerical signs. For example, when animals were being counted the circular sign signified "10," whereas it was to be read "6" when it referred to measures of grain. Also, as long as the cuneiform script existed, one-to-one correspondence continued to express the number of units such as "1" and "10." For example, thirty-three jars of oil were expressed by three tens (three circular signs), three ones (three wedges), followed by the sign for "jar of oil" (Figure 5).

The standardization of measures also progressed at a slow pace and, for a long time, the relation between units continued to vary with the kind of entities dealt with. For example, the units of grain (*ban*, *bariga*, etc.) followed a sequence of factors: 5, 6, 10, 3 compared to 6, 3, 10, and 6 for the units of area measures (*ikus*, *eše*$_3$, *bur*, etc.) (Nissen – Damerow – Englund 1993: 64–65).

CONCLUSION

Between 7500–3000 BC, tokens and writing processed the data of the growing Near Eastern redistribution economy in ever-greater abstraction. Each of the two accounting technologies, tokens and writing, documents one stage of the manipulation of data in abstraction. By abstracting units of real goods, the tokens could manage, one by one, a limited number of casual measures of selected staples. With the abstraction of tokens, numbers and measures, writing raised data management to limitless quantities of any possible unit of goods. Moreover, by abstracting sounds writing reached beyond accounting to take on new functions in communication.

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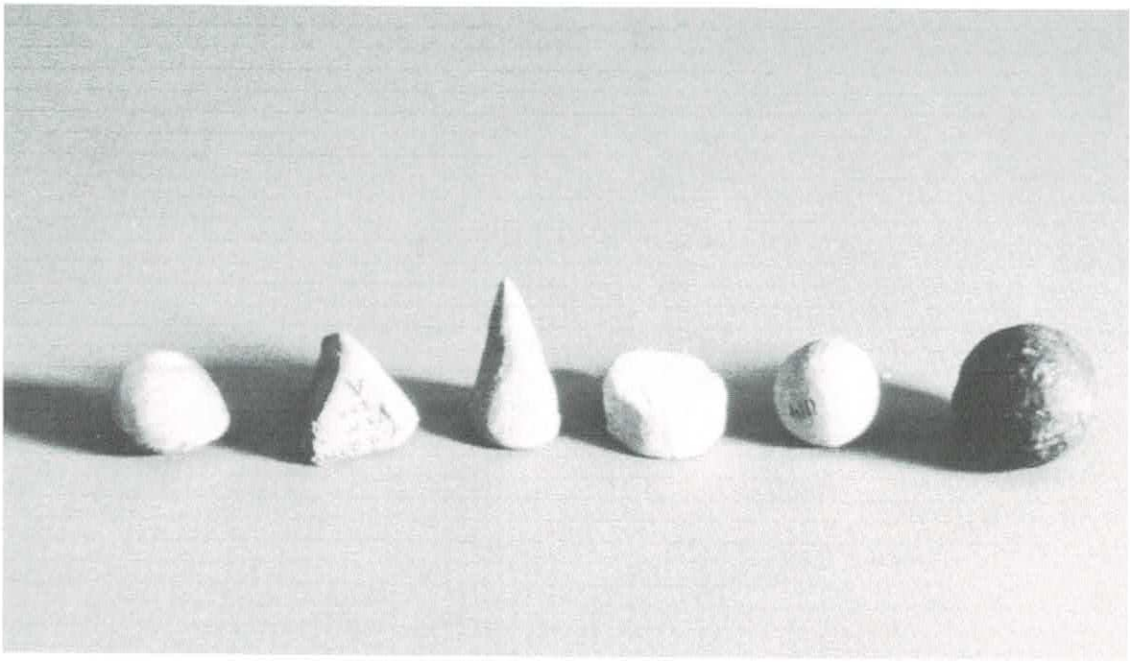

Figure 1. Plain tokens, Mesopotamia, present day Iraq, ca. 4000 BC. The cone, sphere, and disk represented a series of grain measures; the tetrahedron stood for a unit of labor. Courtesy Denise Schmandt-Besserat, The University of Texas at Austin.

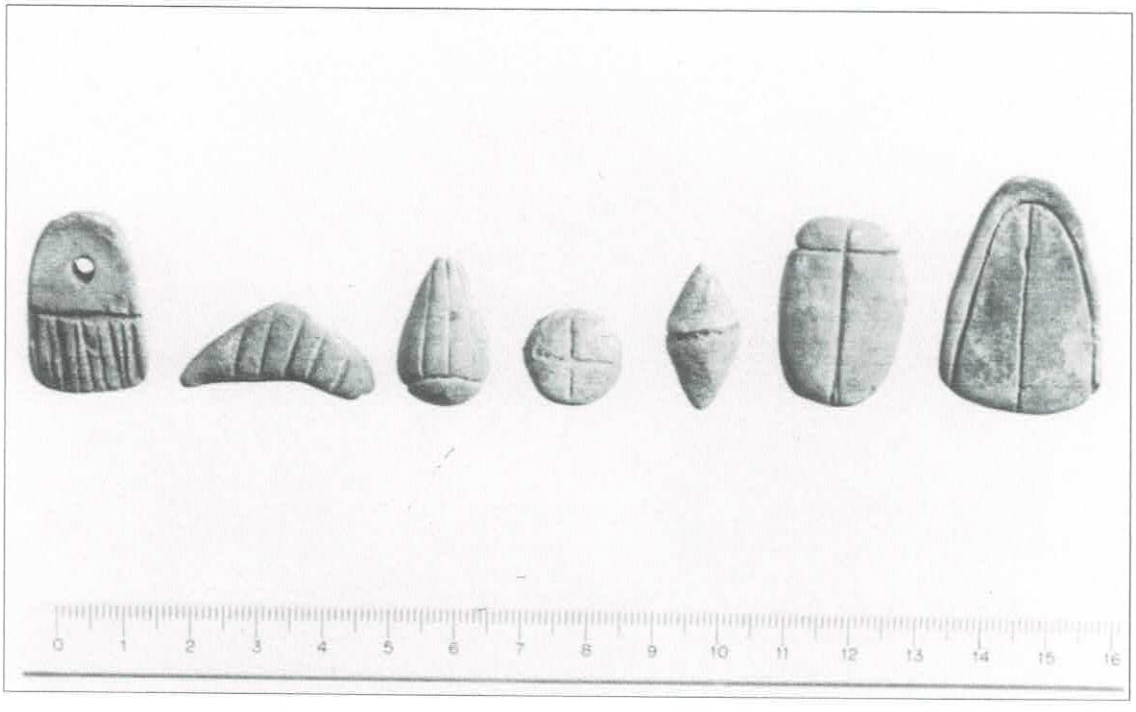

Figure 2. Complex tokens representing, from left to right, one garment, one ingot of metal, one jar of oil, one sheep, one measure of honey, (?), and one garment, from Susa, Iran, ca. 3300 BC. Courtesy Musée du Louvre, Département des Antiquités Orientales, Paris.

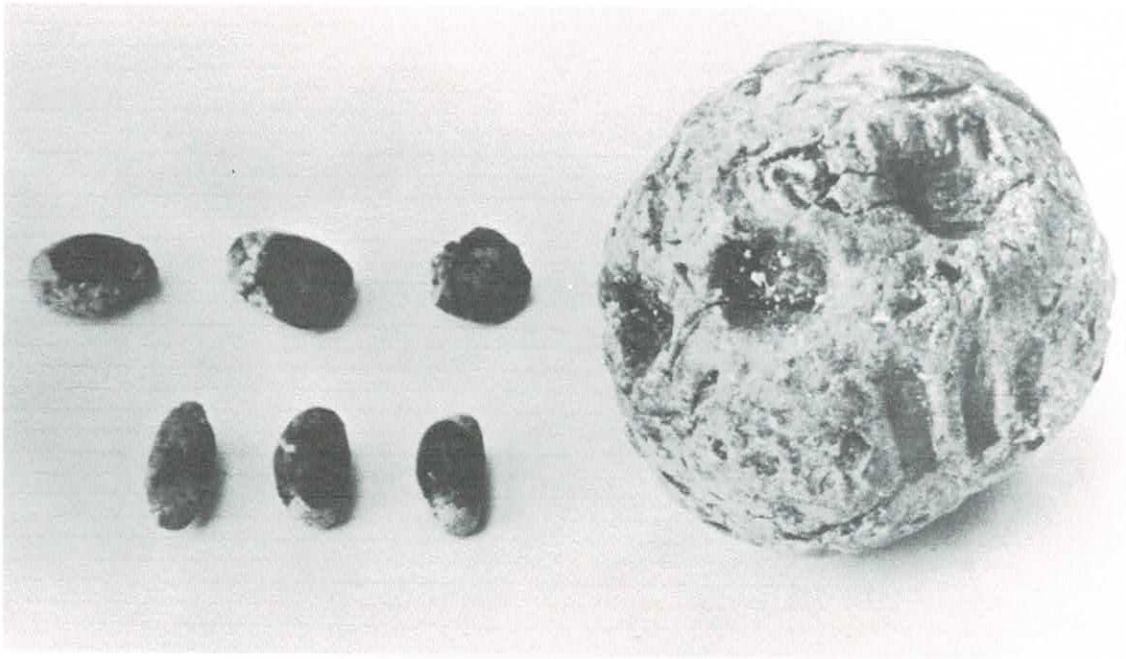

FIGURE 3. ENVELOPE SHOWING THE IMPRINT OF THREE LENTICULAR DISKS AND THREE CYLINDERS (= 33 SHEEP) CA. 3200 BC. COURTESY MUSÉE DU LOUVRE, DÉPARTEMENT DES ANTIQUITÉS ORIENTALES, PARIS.

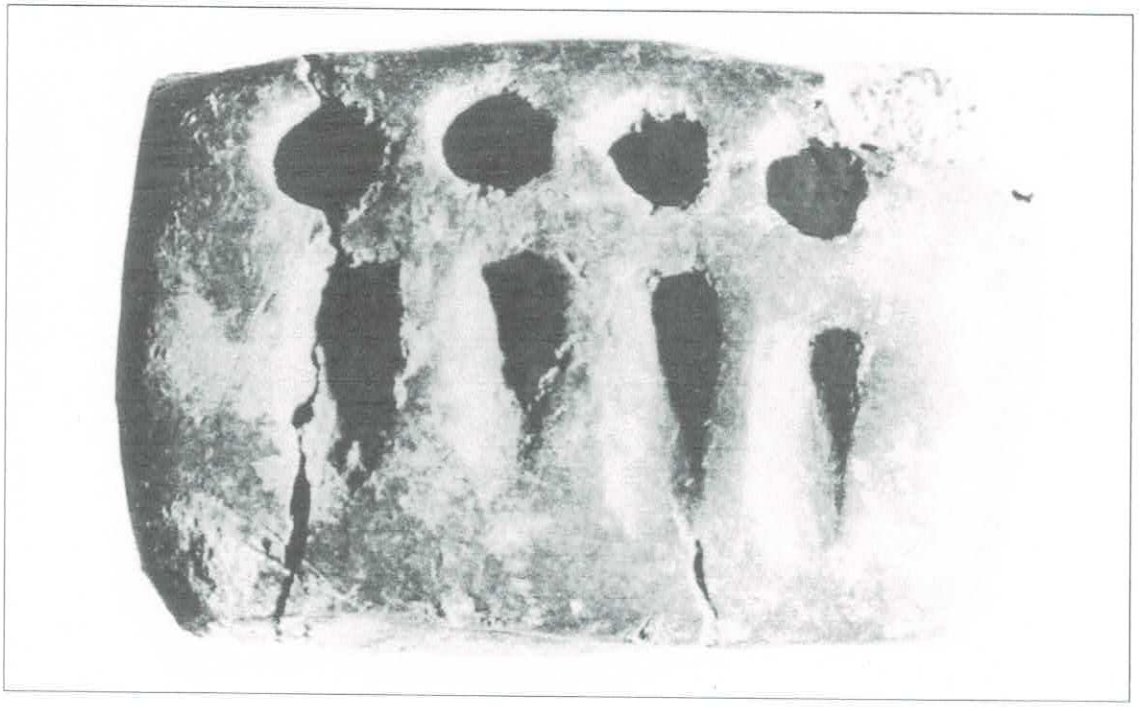

FIGURE 4. TABLET SHOWING THE IMPRESSION OF SPHERES AND CONES REPRESENTING MEASURES OF GRAIN, FROM GODIN TEPE, IRAN, CA. 3200 BC. COURTESY DR. T. CUYLER YOUNG, ROYAL ONTARIO MUSEUM, TORONTO, CANADA.

FIGURE 5. PICTOGRAPHIC TABLET FEATURING AN ACCOUNT OF 33 MEASURES OF OIL, (CIRCULAR = 10, WEDGES = 1) FROM GODIN TEPE, IRAN, CA. 3100 BC. COURTESY DR. T. CUYLER YOUNG, ROYAL ONTARIO MUSEUM, TORONTO, CANADA.

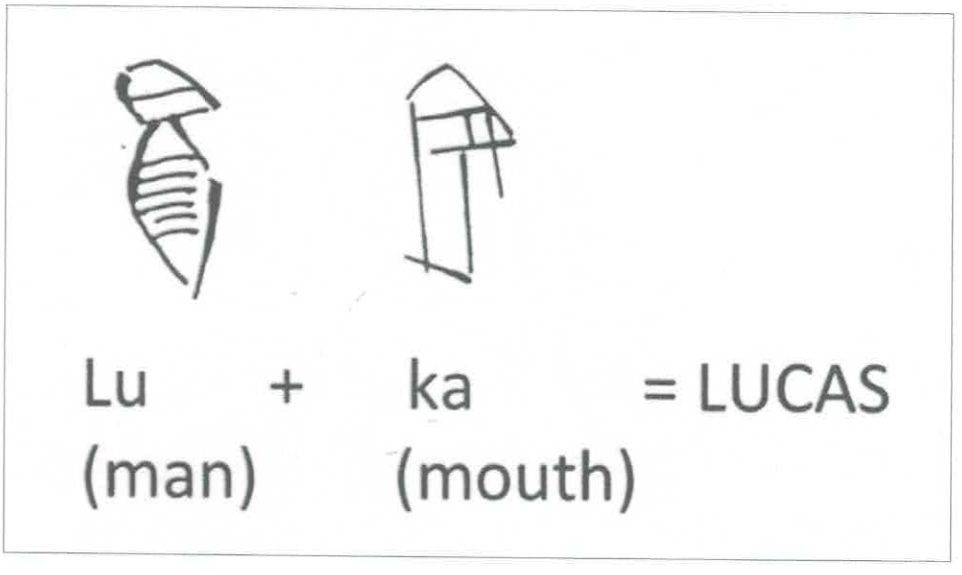

FIGURE 6. EXAMPLE OF THE REBUS PRINCIPLE USED TO RECORD NAMES.

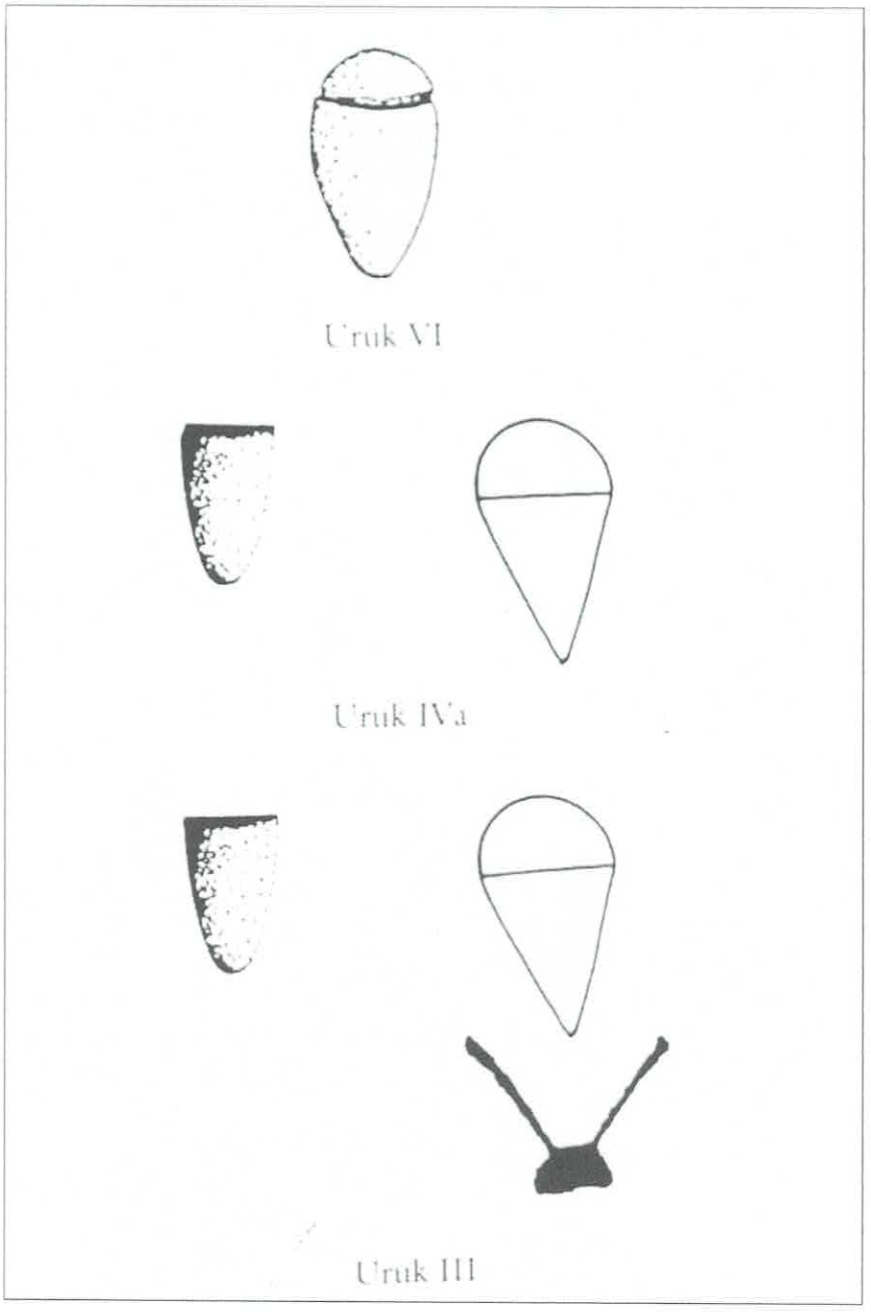

FIGURE 7. THE REPRESENTATION OF "ONE *SILA* OF OIL" IN 3500 BC, 3100 BC AND 3000 BC.