



WEIGHTS AND MEASURES I. PRE-ISLAMIC PERIOD

WEIGHTS AND MEASURES

i. PRE-ISLAMIC PERIOD

Units of weight. The standard unit of weight in the ancient Middle East was the shekel (*šiqḷu*), best known from that of the Babylonian standard. It was enforced throughout the Achaemenid Empire by Darius I the Great (r. 522-486) around 515 BCE. In this system, the shekel stood at 8.40 grams. This is in fact the key unit for understanding the ancient systems of weight, forming part of a sexagesimal table (see [TABLE 1](#)).

It seems likely that during earlier periods in Babylonia, the standard of the shekel was marginally lower, but it is then less easy to determine closely the intended norm. Again, there are indications in the system, and in certain archaic terms found in Avestan texts, that in Persia prior to the establishment of the Babylonian standards, a decimal reckoning of denominations had existed, of which the *karša-* (*AirWb.*, col. 457) of ten shekels is a survival.

One of the indications for the value of the shekel under Darius is that the gold [Daric](#) coin, supposedly weighing a shekel, has a typical weight of 8.33 g. Some consider this as evidence that the shekel standard was minimally lighter than that quoted above, but more probably this figure provided a margin for seignorage, covering costs of minting uncoined, or alien gold brought to the



mint. It supports this theory that the 4th-century BCE gold staters of the Greek city of Lampsacus on the Dardanelles, frequently within the Achaemenid jurisdiction, had indeed a typical weight of 8.4033 g, and were presumably intended for exchange against the Daric at par.

Other evidence for establishing the ancient standards is provided by the examination of actual weights surviving from antiquity, and again from the inspection of certain specimens of ingot currency (see below). Of the six surviving, well-preserved Achaemenid weights recorded in the literature and provided with inscriptions, three seem manifestly related to the shekel of Darius, though again marginally low: British Museum no. 91117 is inscribed 2 *karša* and has a current weight of 166.724 g, resulting in the figure of $166.724/20=8.33$ g for the shekel, thus coinciding closely with the norm of the Daric coin. Two weights from the Persepolis excavations (Schmidt, pp. 105-7), PT3 283 and PT4 736, are inscribed respectively 20 minas/120 *karša* and 10 minas/60 *karša* and weigh 9,950 g and 4,930 g. These would provide a shekel of 8.29 g and 8.22 g, which are again low, but it should be noticed that both these specimens are perceptibly chipped. The weight from Kermān carries simply the name and titles of Darius the Great, and weighs 2222.425 g. This does not seem to bear any intelligible relation to the shekel of 8.40 g, though William Trousdale contended that it represented a weight of 30 *karša* (2,520 g) reduced some 10 percent by damage. More probably, however, it was a special-purpose weight, designed (since $2,222.425 / 400 = 5.56$) for weighing out bulk payments of 400 silver sigloi. These silver coins were the subsidiary denomination to the gold Daric, adjusted to be valued at 20 to the latter coin. An extremely large lion weight from Susa, weighing 121 kg, is evidently, as Mitchell (p. 174 and n. 12) observed, a unit of four talents, since $121 / 4 = 30.25$ kg, coinciding all but precisely with the theoretical standard of the Babylonian talent.

Finally, a puzzling item is the lion weight from Abydos in the Dardanelles at the British Museum (BM E.32625). This was indubitably intended as a full talent and has actually a Greek letter *alpha* for “one” on the back, but in fact it weighs 31,808 g, an approximate 5 percent excess over the theoretical Babylonian standard of 30,240 g. One can only assume that this weight was for checking payments subject to some kind of surcharge. The Aramaic inscription on the weight, reading ‘*sprn l-qbl stry’ zy ksp’* can be interpreted as “correct for (weighing) staters of silver” and suggests that tribute in Athenian silver tetradrachms was being discounted on payment into the Achaemenid treasury, since these were the coins known in the East as “staters.”



Before the time of Alexander the Great, the financial system of the ancient Near East operated chiefly on the basis of payments in bulk silver. This could be presented in any available form, and was evaluated on the balance rather than by counting. Thus value was determined by units of weight rather than by number. There is reason to believe that when state authorities wished to enlarge their tax take, instead of raising the assessment they increased the standard of the shekel. Thus, there are Assyrian “lion” weights that are evidently intended as talents but are double the regular standard, implying a shekel of 16.80 g. Although broken and bulk silver in any form could be employed for payment, in different periods and areas several standard forms of silver unit were typical. Thus spiral “ring-money” was found from very early dates, possibly even earlier than the second millennium BCE, in Babylonia. In Assyrian times, “Slab-ingots,” perhaps 2 cm thick and of rectangular form, seem also to have existed, though hardly any survive intact, since they were regularly cut up to make smaller payments. In southeastern Anatolia, notably at Zincirli, and in Syria, there were “cake-ingots,” shaped like round, flat, “cookies” and often approximating to the weight of a *mina*, but commonly falling short of the full standard. During the 7th century BCE in the area of the Median Empire in northern Persia, “bar-ingots” were favored. The weights of these pieces varied widely, with intact specimens in the Nuš-e Jān hoard reaching as much as 100 g. Nevertheless, certain examples seem to have been carefully adjusted, one offcut from Nuš-e Jān (Bivar, 1982, no. A 13), weighing exactly 8.40 g, and obviously calculated to represent an exact Babylonian shekel.

A later deposit from the residue of the first Mir Zakah hoard from eastern Afghanistan, datable around 385 BCE, had one carefully shaped astragloid bar weighing 8.34 g, the standard weight of the Daric coin, and so it was presumably Achaemenid. One could account for the decline from the theoretical standard of 8.40 g by assuming that Daric coins themselves were employed as weights in the provinces, or that modified weights were in use for weighing these. The same hoard also contained heavier specimens, including two of 11.12 g and 11.13 g respectively, thus each one having the precise weight of two Achaemenid sigloi. This was indeed a weight-standard exemplified in various regions, including possibly eastern Persia. Seven others were heavier still, running up to a maximum of 12.18, and 12.76 g. Though one cannot be sure that all, or any, of these ingots were precisely adjusted, they do suggest heavier standards than that of Darius, which had once prevailed in different parts of the Iranian world. Another interesting Mir Zakah piece was a



fragment weighing 1.39 g, which could be identified as the *dānake* “grain”; since, when multiplied by eight, it equates with the unit of 11.12 g, and when multiplied by six results in the shekel of Darius at 8.34 g. Thus we see that the study of ingot hoards casts light on the development of weight standards in the Achaemenid world.

With the advent of Alexander of Macedon in 333 BCE, coined money began to circulate in the former Achaemenid territories. The conqueror adopted for his currency the widespread Attic (Athenian) standard, generally called the “Euboic,” with a stater of 17.3 g, and its quarter, the Attic drachma, at 4.32 g. Very soon, however, though fine presentation pieces may have maintained the higher standard, the coinage of Alexander’s successors in Asia (now being issued from mints at Ecbatana, Susa, Persepolis, and Bactra), tended to fall back to that of the Babylonian shekel, with the tetradrachm or stater at 16.80 g equating with two shekels, and the drachma of 4.20 g with the half-shekel or *zwt*. With some gradual slippage of the standard, these denominations survived throughout the Parthian and Sasanian dynasties. At the same time, commercial weight-standards began to diverge from that of the coinage, but they can, to some extent, be followed from the metrological inscriptions engraved on many silver dishes, evidently for purposes of accountancy.

These inscriptions were expressed in staters and drachmae, either spelt out phonetically (*styr* and *drhm*), or with the use of the equivalent ideograms *ḤṢY* and *ZWZN*. Thus on a now well-known fluted dish bearing a device characteristic of the reign of Bahrām II (r. 274-91 CE) and weighing 650 g, a Pahlavi inscription reads *TGDWN ’smy 20 10 9 ḤṢY 3* “Weighed, silver 39 staters and 3 drachmae.” Thus the calculation $39 \times 4 + 3 = 159$ gives the total weight of the object in drachmae, and $650 / 159 = 4.08$ g will be the standard of the *drahm* (see [DIRHAM](#)) at that period. A cursive Pahlavi inscription on an evidently later silver pedestal cup in private possession reads *Ḥ iii iii / ZWZN* (i.e., *drahm*) ii, thus totaling 26 drachmae. Since the present weight of the vessel is 102 g, the calculation $102 / 26 = 3.92$ g establishes the standard of the *drahm* at this later date as 3.92 g, which is probably not much earlier than the 6th century CE (Bivar, 1991, pp. 4, 8).

Thus after the earliest Sasanian reigns, the standard of the *drahm* coin, the dominant currency unit, had declined to a typical figure of around 3.90 g, which persisted until the fall of the dynasty in the mid-7th century. As Walter B. Henning (1961, p. 8, n. 18) observed: “The maximum average weight of the coins issued by the early Sasanian kings from Šāpur I [r. 240-70] to Bahrām V [



r. 420-38 CE] never falls below 3.90 nor rises above 4.05 g.”

In the more easterly territories of the Greco-Bactrian kingdom, the earlier Bactrian kings issued coinage on a standard reduced only marginally, if at all, from that of their Seleucid predecessors, with a tetradrachm (stater) from 16.80 g to 16.50 g. Especially towards the decline of the kingdom and the Scythian invasions, the standard again fell substantially, to around 15.50 g in some examples. This figure for the stater of the later Bactrian kingdom is confirmed by two artifacts from the Tillya-Tepe find in northern Afghanistan. Though this treasure was probably deposited in graves towards the end of the 1st century BCE, it contains several “heirloom” pieces of evident Hellenistic manufacture. Here a cylindrical gold casket with leaf decoration bears an inscription *CTA E t B* “Sta(ters) 5, drachmae 2.” The weight of the object in drachmae is therefore 22, and its present weight 86 g. Consequently the calculation $86 / 22 = 3.90$ gives the weight of the late Bactrian drachma, and $3.90 \times 4 = 15.6$ g is that of the stater. A closely similar result is obtained from a golden phiale weighing 638 g, and inscribed *CTA MA* “Sta(ters) 41.” Again, $638 / 41 = 15.56$, giving the contemporary weight of the stater. In each case, the numerals use the Greek “alphabetic” system of numbering, and in the first a conventional sign appears indicating the presence of drachmae (cf. Woodhead, p. 109, where the drachma sign has a slightly different form, and p. 111).

Very similar weight standards are found in a few substandard specimens of the earlier Greco-Bactrian coinage, but especially in the latest, “helmeted head,” issue of the coinage of Heliocles (e.g., Bopearachchi, p. 225, no. 23, 15.10 g). Thereafter, the designation of stater, attached to a variety of coin- and weight-standards, becomes widely diffused in Central Asia, and later in India. It survives in the New Persian designation *sir* and *sēr* as a commercial weight found in the markets of Persia and South Asia down to recent times.

Units of capacity. The dominant units of capacity in the Achaemenid period are defined by a vessel recovered in the excavations at Persepolis. As in the case of weight-units, the reforms of Darius seem to have made an attempt to harmonize the Babylonian and Old Iranian systems. Erich Schmidt (pp. 108-9), calculating from the estimated capacity of a cosmetic bottle found in Ernst Herzfeld’s excavations, reckoned the volume of the measure known by the Babylonian logogram QA as between 920.4 and 944.9 ml. A practical approximation would be 932 ml. It may be assumed that the QA was identical with the *ḥōfan*, the measure known in Aramaic texts as the *ḥpn* (cf. Akk. *upnu*),



which constituted the standard daily ration of flour for a soldier or workman (Driver, pp. 28, 60). The *hōfan* (epigraphic spelling now *hwpn*) appears again in the inscription of Šāpur at Ka'ba-ye Zardošt (see Huyse, p. 49, l. 36) in a figure of one *grīw*, five *hōfan*. In the Greek version of the inscription, this is rendered as “one and a half *modius*,” thus equating the *grīw* with the Greek *modius*, and designating the *hōfan* as its tenth. Consequently the value of the *grīw* could be reckoned at 9.32 liters.

The next highest unit on the scale of capacity was the (Gk.) *artabē*, (Elam. *irtiba*; Aram. *ʿrdb*), approximately equivalent to the English “bushel,” and defined by Herodotus (1.192) as exceeding the Attic *medimnus* by three *choenices*. Since the *choenix* was established as 1.09 liters, the daily meal ration of an Athenian soldier, the excess would be 6/48ths, or 6.25 percent. The Attic *medimnus* has been calculated at 52.40 liters (Young), though different calculations result in slightly varying figures, and on this basis the *artabē* should amount to 55.67 liters. An even higher volume mentioned by Aristophanes (*Acharnians* 108) was the *achanē*, corresponding to a wagonload, and estimated as 45 *medimni*, or possibly 45 *artabae*, and therefore $55.67 \times 45 = 2,505$ liters.

The Elamite Fortification tablets from Persepolis also provide evidence for the Achaemenid systems of dry and liquid measure. The unit in dry measure, known by the logogram BAR, which must be identified with the *grīw*, evidently corresponds to the *marriš*, Gk. *máris*, in liquid measure. Both are composed of 10 QA, and should therefore amount to 9.32 liters. We find here, however, conflicting evidence for the *artabē*, which in these documents consists of only 3 BAR or *grīw*, amounting therefore to only 27.96 liters. Here we have therefore a contradiction with the evidence of Herodotus, and, if the equivalences of the Elamite tablets have to prevail, then all the values of the *artabē* and above need to be halved, though allowance should also be made for diachronic changes. A further unit occurring in these tablets is the *bawiš*, of which there are ten to the *artabē*. This will accordingly correspond to 3 *hōfan*, or 2.79 liters.

Liquid measures follow the same pattern as those of dry volumes. Here the main units are the *maris*, in Parthian documents *mry*, similar to the *grīw*, and the *kapithē* or *kapezis*, rendering the Parthian **kapīc* and representing the quarter of the *maris*. In the wine documents from Nisa (Diakonoff and Livshits), these are often represented by the abbreviations *m* and *k*. In New Persian, **kapic* survives as *qafiz* (see Hinz, tr., pp. 71-72, where a variety of



qafiz is discussed) or *kafiz*. In the Šāpur KZ inscription l. 36, a further liquid measure is attested, the *pās*, but there is no evidence to define this closely (see TABLE 2).

Units of length and distance. The principal units of length in the Near Eastern measurement systems were the foot and the cubit, standing in the ratio of 1:1.5. Subdivisions of the foot were its quarter, the palm, and its 16th, the finger. A higher unit, the fathom, consisted of four cubits. Michael Roaf (p. 68) has calculated from the measurement between builders' marks on the palaces of Darius and Xerxes I (r. 486-465) at Persepolis that the value of the cubit was there 52.1-52.2 cm, and of the foot 34.7 – 34.8 cm. An interesting parallel is provided by a metrological relief kept at the Ashmolean Museum (Michaelis, p. 335-38) in Oxford, which illustrates a "Samian" fathom of 208cm, implying (since $208 / 4 = 52$) a cubit of 52 cm, thus effectively identical with the Persopolitan unit. This sculpture has also an added indication of the "Attic" foot, of 29.7 cm, evidently a lower standard implying a cubit of 44.5 cm. As Roaf has pointed out, drawing here mainly on Egyptian evidence, there are many allusions to the "royal" and the "common" cubit in ancient sources. The two standards exemplified on this metrological relief may effectively represent these two different standards. There exists, however, evidence also for intermediate figures at other sites, for example the minimally varied figures calculated by Carl Nylander (pp. 96-97) for Pasargadae, which suggests that the full picture may have been somewhat more complicated.

A link between the measures of length and of distance seems to be provided by the Attic foot of 29.7cm, which may have been identical with a "common" Babylonian foot. In the Greek measurement systems, 600 feet were equivalent to one stade, defining the Attic stade as 178.20 m. Herodotus (2.6) reports that the best-known Persian measure of distance, the parasang, was equivalent to 30 stades. The result is a parasang of 5.35 km, or 3.3 English miles. This fits well with the widespread tradition that the parasang represents the distance that men could march in an hour. The memory of this distance survives even today in the well-known, but nowadays more approximative, understanding in Iran of the *farsang* or *farsak* (today about 6 km, see Hinz, tr., p. 91, probably indicating the horseman's parasang).

John Hansman (1981, p. 3) in his search for the site of Hecatompylos (Qumes) worked with a somewhat shorter stade (of 164 m), derived from distances on the ground. He reckoned, as a rule of thumb, 10 stades to the English mile (1.609 km) and 3 miles (4.48 km) to the parasang, which is somewhat short of



the above figures but produced excellent results in practice.

Herodotus (2.6) notes a further unit of distance, the Greek *schoenē* “rope,” which he defines as 60 stades or two parasangs, consequently 10.7 km. This unit seems identical with the Babylonian *bēru*. François Thureau-Dangin estimated the *bēru* at 3600 *qanu* “reeds” of 2.97 m, or 10.69 km. It is the “reed” that provides a common factor between the Babylonian and Attic systems, since it is evidently equivalent to ten Attic feet.

The discovery in situ of contemporary distance-stones would be of the greatest value. However, though Assyrian distance-stones have actually been reported (Olmstead, pp. 271, 334, 556; Nemet-Nejat, pp. 273-74), efforts to derive the word “parasang” from the OP *aθanga-* “stone” seem not to be substantiated, and no distance-stone of Achaemenid date, from which measurements could be taken, is so far recorded. It is possible that the Achaemenids reckoned road-distances not by chain-survey but by the timings of marching men, measured with some device similar to an hour-glass.

An even longer measure of distance possibly used by the Achaemenids is reflected in an Aramaic inscription of the Indian emperor [Aśoka](#) (r. 269–32 BCE) found at Laḡmān in Afghanistan (Dupont-Sommer, pp. 165-66), where the distance from that spot to Tadmor (Palmyra) is quoted at 200 *qštn* “bows.” André Dupont-Sommer estimates the distance from the find-spot to Palmyra as 3,800 km, which would result in a unit of 19 km, suitable for a day’s stage. In routine marches under tropical conditions, four hours per day on the road might be reasonable travel, resulting in a parasang of 4.75 km, intermediate between the extreme figures we have been contemplating.

Numerous measures of length and of distance are mentioned in Avestan and Pahlavi texts, notably in the *Vidēvdād* and the *Nērangistān*. Walter B. Henning (1942, pp. 235-37) concluded that these late works were influenced by the Attic-Roman systems, but there is little evidence for the absolute values of the terms. The terms recorded are: Av. *paða-* (Mid. Pers. *pāy*) “foot,” Av. *frārāθni-* (Mid. Pers. *frārāst*) “cubit,” Av. *gāya-*, *gāman-* (Mid. Pers. *gām*) “pace,” Av. *vibāzu-* (Mid. Pers. *jud-nāy*) “fathom,” and Mid. Pers. *nāy* “reed” (*AirWb.*, cols. 522, 842, 1021, 1448). A different system is reflected by presumably earlier texts such as the *Yašts*, involving the *hāθra-*, and its double, the *tačar* or *čarātu-* (*AirWb.*, cols. 582, 628, 1802). Efforts by the Pahlavi glossarists to define the first are puzzling, since it is explained as the parasang, as an hour’s journey, or conflictingly as a quarter-parasang, or even as 1000 paces (the Roman mile).



Ernst Herzfeld (p. 21) explained the *tačar*- as related to the term for horse-race. He observed that nine circuits of the great 'Abbasid race-track at Sāmarrā', a typical endurance course, measure 10.5 km, and are thus a double-parasang, which fits well with the first interpretation of the *hāθra*-. Thus the *tačar*- would coincide with the Babylonian *bēru*. One might seek a semantic link with the name of the palace of Darius the Great at Persepolis, also called *Tāčara*, if a possible shade of meaning were a "grandstand" or "pavilion," naturally associated with a racecourse.

BIBLIOGRAPHY

A. D. H. Bivar, "Achaemenid Coins, Weights and Measures," in *Camb. Hist. Iran* II, pp. 610-39.

Idem, "A Hoard of Ingot-currency of the Median Period from Nūsh-i Jān, near Malayir," *Iran* 9 1971, pp. 97-111.

Idem, "Bent Bars and Straight Bars: An Appendix to the Mir Zakah Hoard," *Stud. Ir.* 11, 1982, pp. 49-60.

Idem, "The Ideogram for 'Staters' in Pahlavi," in Ronald E. Emmerick and Dieter Weber, eds., *Corolla Iranica: Papers in Honour of Prof. Dr. David Neil MacKenzie on the Occasion of His 65th Birthday on April 8th, 1991*, Frankfurt am Main and New York, 1991, pp. 3-14.

Osmund Bopearachchi, *Monnaies gréco-bactriennes et indo-grecs: catalogue raisonné*, Paris, 1991.

I. M. D'iakonov and V. A. Livshits, *Parthian Economic Documents from Nisa I. Corpus Inscr. Iran.*, London, 1977.

Godfrey Rolles Driver, *Aramaic Documents of the Fifth Century B.C.*, Oxford, 1957.

André Dupont-Sommer, "Une nouvelle inscription araméenne trouvée dans la vallée de Lamghan (Afghanistan)," *Comptes Rendus de l'Académie des*



Inscriptions et Belles Lettres, 1970, pp. 158-73, esp. 165-6.

Richard Treadwell Hallock, *Persepolis Fortification Tablets*, Chicago, 1969.

John Hansman, "The Problems of Qumis," *JRAS* 1968, pp. 111-39.

Idem, "The Measure of Hecatompylos," *JRAS* 1981, pp. 3-9.

Walter B. Henning, "An Astronomical Chapter of the Bundahishn," *JRAS*, 1942, pp. 229-48.

Idem, "A Sasanian Silver Bowl from Georgia," *BSO(A)S* 24/2, 1961, pp. 353-56.

Ernst Herzfeld, *The Persian Empire: Studies in Geography and Ethnography of the Ancient Near East*, ed. Gerold Walser, Wiesbaden, 1968.

Walther Hinz, *Handbook Islamische Masse und Gewichte: umgerechnet ins metrische System*, tr. M. I. Marcinkowski as *Measures and Weights in the Islamic World*, Kuala Lumpur, 2003.

Philip Huyse, *Die dreisprachische Inschrift Šābuhrs I. an der Ka'aba-i Zardušt (ŠKZ)*, Corpus inscr. Iran. 3, Pahlavi Inscriptions, Royal Inscriptions, with Their Parthian and Greek Versions, London, 1999.

A. Michaelis, "The Metrological Relief at Oxford," *Journal of Hellenic Studies* 4, 1883, pp. 335-50.

T. Mitchell, "The Bronze Lion Weight from Abydos," *Iran* 11, 1973, pp. 173-75.

Karen Rhea Nemet-Nejat, *Daily Life in Ancient Mesopotamia*, London, 1998.

Carl Nylander, *Ionians at Pasargadae: Studies in Old Persian Architecture*, Uppsala, 1970.

Albert T. Olmstead, *History of Assyria*, New York, 1923. Michael Roaf, "Persepolitan Metrology," *Iran* 16, 1978, pp. 67-78.

E. S. G. Robinson, "The Beginnings of Achaemenid Coinage," *NC*, 6th Series 18, 1958, pp. 187-93, especially p. 190.

Viktor Ivanovich Sarianidi, *The Golden Hoard of Bactria: From the Tillya-Tepe Excavations in Northern Afghanistan*, New York and Leningrad, 1985.



Erich Friedrich Schmidt, *Persepolis II: Contents of the Treasury and Other Discoveries*, Chicago, 1957, pp. 105-9.

Angelo Segré, *Metrologia e circolazione monetaria degli antichi*, Bologna, 1928.

Idem, "Babylonian, Assyrian and Persian Measures," *JAOS* 64, 1944, pp. 73-81.

François Thureau-Dangin, "Numération et metrologie sumerennes," *Revue asiatique* 18, 1921, pp. 123-42.

William Trousdale, "An Achaemenid Stone Weight from Afghanistan," *East and West* 18, 1968, pp. 277-80.

Arthur Geoffrey Woodhead, *The Study of Greek Inscriptions*, Cambridge, 1959, p. 111.

S. Young, "An Athenian Clepsydra," *Hesperia* 5, 1939, pp. 279-80.