houses leads down the south side of the great temple, but many of these remains will, of course, be destroyed by the German excavations. The Arab constructions of a still later age will absolutely disappear as the work progresses. Such a fate is, perhaps, inevitable, although much to be regretted. The amount of interesting information which has already been gained upon the subject of the older religion and its monuments must be a compensation for the loss of later history and Arab associations.

HEBREW WEIGHTS AND MEASURES.

(*See "Quarterly Statements" for July and October*, 1899.)

By Colonel C. R. Conder, LL.D., &c.

Having read carefully the valuable papers by Sir C. Warren, I venture to approach the question of Hebrew metrology from the point of view of actual remains, rather than from any theory of proportion. The results do not conflict, but I think in detail that other proportions may be established pointing either to different ages, or to various sub-divisions of the units—which may have co-existed.

The accuracy of the ancients was not apparently as great as that of modern systems, and the measurement of ancient buildings generally shows this. Units so derived are liable to error from several causes. 1st, that the original measures were not quite exact—angular measurement especially. 2nd, that when a large number of measurements are collected from various sources some may have been less careful than is required, and measurements in feet or metres may be influenced by the modern units. 3rd, that such measurements are capable of being referred to more than one unit. Unless actual measuring rods, measures of capacity, and weights can be consulted, no decisive check can be established, and scholars have deduced different conclusions from the same data, and from the same literary statements. In our own time the accuracy of Orientals is still inferior. In Palestine the measures of capacity, and the value of European coins, differ among the peasantry in almost every village. But among the Jews and Babylonians standard measures certainly existed, which kept the various units fairly constant.

In Orientation Dr. Peters observes that the angles differ by as much as 8° in various *Ziggurats* placed with the angles to cardinal points.[1] In Egypt the known specimens of the cubit vary between 21·05 and 20·47 inches, according to Sir Gardner Wilkinson.[2] In Jerusalem the height of the "master course" of the south wall of the Haram differs—as Sir C. Warren informs me—by some 4 inches in various parts; and the same absence of complete accuracy is observable in extant weights. But the variations do not forbid us from obtaining substantial results, which may be stated in round numbers.

That the Babylonians—perhaps as early as the seventh century, or earlier—calculated the squares and cubes of numbers we know from extant tablets. The Egyptians did the same, and no doubt used the abacus as Sir C. Warren states. In the Rhind Papyri (No. 79 on Plate XX) occurs an instance (*see* the paper by Mr. F. L. Griffith, "Proc. Bib. Arch. Soc.," June, 1894, p. 241), where we are given the values of $7 + 7^2 + 7^3 + 7^4 + 7^5 = 19{,}607$. The total is correct, though 7^4 is made 2,301 for 2,401. Hence the sum was not reached by multiplication only.

The blunders in these Papyri, and the clumsy reckoning, show, however, that calculation was difficult, and that errors were often made. An attempt to compare the areas of a square and its inscribed circle (No. 48) fails. The area of the same circle in another case (No. 50) was apparently obtained pretty closely, though 60,000 is in one line incorrectly written for 6,000. A square of 10 × 2 *khet* (No. 49) is made to be 1,000 square cubits, but should be 2,000. Thus, although the proportion of the circumference and diameter had been measured as nearly as 22 to 7, yet the calculations of the Egyptians were not always correct.

Deductions from literary statements are also subject to doubt. Numbers (as we see in Josephus, in Manetho, and even in the Old Testament) were often miscopied. Comparisons with other systems were not always minutely exact, and the actual value of the unit compared is also often disputed. The text has sometimes been corrupted, and the statement is sometimes only approximate, as when the circumference and the diameter are in the Bible stated as 3 to 1 in proportion (1 Kings vii, 23). The dimensions and

[1] "Nippur," vol. ii, p. 120.

[2] "Ancient Egyptians," vol. ii, p. 386 (ed. 1878).

distances given by Josephus do not agree as a rule closely with the facts as ascertained by exploration, nor does he give the same measurement in parallel passages. These sources of error have led to many discrepancies in the results of calculation by various scholars.

Even monumental information is not always quite reliable. The variation in weights and in lengths may be due to the use of measures not up to the standard, or to the gradual depreciation of the standard itself, or to inaccurate measurement by the student (as in the case of certain Babylonian weights), or to uncertainty as to the amount lost by wear in the specimen itself.

The tendency to depreciate the standard is very general. The oldest Babylonian weights of 1500 B.C., or earlier, are found to be heavier than those of about 700 B.C. The drachma weighed about 66·5 grains in Attica about 600 B.C., and was apparently the origin of the Roman denarius which, under Augustus, weighed 60 grains, and was reduced within a century to about 53 grains by Nero. The tendency in trade was to reduce the weight, the capacity, and the measure of length in favour of the merchant. Hence in comparing standards it seems best to use the oldest perfect specimens and the longest known units of measurement. An "average" may mislead, and the question of date becomes very important.

The units appear to have had a natural origin. Such words as "finger," "arm," "foot," &c., used in Hebrew and in Arabic, show this for the lengths. The "barleycorn" was also a measure among Jews and Arabs, both for length and for weight, and it seems fairly clear that measures of capacity were intended to hold a definite weight of water (for liquid), and of barley (for dry) measure. But in such calculation we cannot rely on modern proportions or on modern barley. It has been conclusively shown by Darwin that domestic animals have largely increased in size and weight, and that corn under cultivation has also so increased. The average height of mankind in ancient times is a subject which is as yet imperfectly studied. In pre-historic France the early Palæolithic race of "Canstadt" was short though powerful, as was the "Grenelle" race, which resembled the Lapps. The "Cro-magnon" race, on the other hand, was tall. The Egyptians appear to have been slight, and the famous Thothmes III appears to have been a small man. Some specimens of Greek armour

also are small, but at Nippur[1] the bones of a very tall person (perhaps of Akkadian race) were found in a coffin of the Kassite age, or about 1500 B.C. The Semitic race has smaller hands and feet, at the present day, than have the Teutonic races, and I should suppose their average stature to be less. Sir C. Warren states the average of male adult Jews, "throughout Europe" at the present day, as 64 inches in height. This may be due to the large proportion of Polish and other poor Jews (as low as 63 inches); but if it includes all the prosperous German Jews of the west and the taller Sephardim it may not be far from the true average, and the ancient Semitic races were probably not taller than the modern. Stature depends on climate and on good food, and in neither respect are the earlier races of Syria and Babylonia likely to have been better off than the modern Arabs. An average of 5 feet 11 inches for grown men appears to me improbably high. The expression "cubit of a man" (*īsh*, Deut. iii, 11) does not seem to mean more than "forearm of an adult male" (Fem. *ishshah*). With such reservations the question must be treated, and the whole of the proportions based as far as possible on extant specimens of the units, or on actually known measures.

Measures of Length.

There is no dispute as to the existence in Egypt of a cubit of about 20·6 inches,[2] divided into 7 palms. Specimens are known, and the "palm" was thus clearly about 2·95 inches, representing a moderate sized hand. There was also another cubit of about 21·6 inches, or less, in use, but not supposed to be equally ancient. The Egyptian cubit was likely to be used by early Greeks who were under Egyptian influence. As to the cubits of Babylon and Assyria we have no information founded on actual specimens, which, as far as I can ascertain, have not been recovered by any explorer.[3]

[1] Peter's "Nippur," vol. ii, p. 221.

[2] [It is curious that a cubit of 20·62 inches seems to have been one of the standards of measure in use in the construction of the ruins of Zimbabwe (J. T. Bent, "Ruined Cities of Mashonaland," 1896, p. 152).—ED.]

[3] The scale on one of the statues at Tell Loh (perhaps 2800 B.C.) bears no title to show what unit it represents. The length (10·53 inches) answers, as will be seen, very closely to the Hebrew foot of 10·66 inches. The text on this

Among the Hebrews we have an indication in the Siloam tunnel inscription giving the length as 1,200 cubits from the source to the pool. The actual length is about 1,707 feet, which would show that the cubit was not that of 7 palms of Egypt, and if the statement is exact it indicates 17·1 inches for the cubit used about 700 B.C. But there are several uncertain points in this calculation: (1) The number 1,200 is a round number and may be only an approximation. (2) The tunnel is very difficult to measure, and if not measured with great accuracy the result would be shorter than it should be. An error of a tenth in the distance of nearly a third of a mile would be possible for the ancient Hebrew measurers, and the attempt which I made in 1881 to discover measurement marks led to no result.

The measurements of Syrian barley made by Colonel Watson, R.E., quite agree with my own measurements, also of Syrian barley; yet his results do not seem to be incapable of another explanation. Sir Charles Warren has quoted the Arab authorities (*Quarterly Statement*, July, 1899, p. 228, note), who speak of a cubit of 144 grains of barley—6 grains 1 finger, 4 fingers 1 palm, 6 palms 1 cubit, but I am not aware of such a statement as made by Jewish writers. In the Mishnah ("Kelim," xvii, 9) we read of the two standard cubits in the Temple, and the commentators (*see* "Menachoth," 97*a*) state that the building cubit was of 6 palms, and that used for the vessels of 5 palms. The "finger" is stated as measuring 2 barleycorns in length, while 2 such corns in length were equal to 7 placed side by side.[1] If we take the width given by Colonel Watson (0·123 inch per corn) the 7 would measure 0·861 inch and the length of the corn would be 0·43 inch. This, however, is impossible, since the modern European barley (which is larger than the Syrian), when the point has not been broken in the bag, has (as I have ascertained from an average of 229 grains) a length not exceeding 0·35 inch. Either, therefore, the Jewish calculation is wrong, or the barley is to be measured not laid flat but on edge. The European barley, when laid on edge and closely packed, gives (as an average of about 130 grains)

statue is Akkadian, not Semitic Babylonian. This scale is divided into 16 parts (2 barleycorns each).

[1] The reference has been kindly given me by Dr. Chaplin. It is in the tract by Maimonides, *Sepher Torah* (ix, 9); and the labours of this great Jewish scholar on the subject are of high value.

a thickness of about ·095 inch, so that 7 grains on edge are closely equal to 2 laid end to end.[1]

The European barley is larger than that from which our measure "3 barleycorns 1 inch" was taken, and the weight is probably also greater than that of Palestine barley about 200 A.D. or later. It will be seen in dealing with weight that the Jewish barleycorn was the Imperial grain, whereas the European weight is apparently about 1·06, giving a carat of 3·18 grains.

Even the Syrian barley of to-day is probably both too large and too heavy for comparison. The old Arab *ḳîrât* gives a grain of only 0·99 Imperial grain, and a width of only ·111 inch. Hence we may fairly suppose that the Hebrew barleycorn of 1 Imperial grain represented a third of an inch in length, or 48 to the cubit, as against about 45·8 barley grains in the same length, which results from the measurement of 229 European grains laid end to end.

Measurements based on so small an object, when 144 or 48 have to be placed together, are liable to an error, which is largely increased when multiplied to the cubit length. It is safer to take larger units and work back to the smaller. Thus, we may commence with the longest Arab measure of the body, the *dhrâ'* or "arm," of 27 inches or less. It was used by Mejr ed Dîn in the fifteenth century, and his measurements of the Ḥaram at Jerusalem, though slightly short, are correct:—

77	*Dhrâ'*	..	173·3 feet, actual length		177
669	„	..	1,505·3 „	„	1,514

This *dhrâ'* he calls the "common *dhrâ'*"; and the Stambuli *dhrâ'* is 26·66 inches. The *dhrâ'* is the "arm," and the half *dhrâ'*, or corresponding cubit, would thus be from 13·5 to 13·33 inches (evidently a cubit of 5 palms), while it is made up as below:—

Dhrâ'	..	..	27[2]	inches or	26·6	inches.
Rub'a	..	..	6·75	„ „	6·66	„
Ḳîrât	..	..	1·125	„ „	1·11	„

[1] This experiment I made by laying the barley grains along ruled lines on putty. They are thus prevented from slipping, and kept straight, but can be easily moved and packed.

[2] These are the modern Egyptian lengths, the second column being the corresponding Stambuli divisions of the *dhrâ'*.

This agrees with the barleycorn ·1125 or ·1111 inch wide, which corresponds to the light weight of ·99 Imperial grain. Hence the ordinary cubit of 6 palms would be made up as below :—

Grain	..	·1125 inch	or	·111 inch.
Finger	..	·6750 ,,	,,	·666 ,,
Palm	..	2·7500 inches	,,	2·666 inches.
Cubit	..	16·5000 ,,	,,	16·000 ,,

A cubit of 16 inches thus corresponds to the Stambuli *dhrâ'*, and may be taken as a round number.

If we follow the statements of the Talmudic commentators, we arrive at the same result for the Hebrew cubits. Probably no other writers have given as much attention to the subject; and the definition of weights and measures was of great importance to the Rabbis, in their earnest inquiry into the law. If we assume that the barleycorn was the unit of weight and of length, and that it was less than the modern European grain, we must suppose that it could not exceed ·33 inch in length, and, according to the Rabbis, had a thickness of ·094 inch. The results would be as follows compared with the Stambuli standard still known in Egypt :—

	Hebrew.		Arab.
——	Barleycorns.	Length.	Length.
		inches.	inches.
Corn	1	·33	—
Finger	2	·66	—
Palm	8	2·66	2·66
Hand	16	5·33	—
Span	24	8·00	—
Foot	32	10·66	—
Cubit (1) ..	40	13·33	13·33
Cubit (2) ..	48	16·00	16·00
Cubit (3) ..	56	18·66	—
Cubit (4) ..	64	21·33	—
Cubit (5) ..	80	26·66	26·66

The ordinary building cubit and the Moslem sacred cubit are thus about 16 inches; and the cubit of 10 palms (*see* Buxtorf, "Lex.," under *Ammah*) is equal to the Stambuli *dhrâ'*.

These calculations are, of course, only evidence of the measurements in use about 200 A.D., or later, which may not have been those of the early Hebrew age. But they are all we have, and they are probably reliable. It may be objected that a palm of only 2·66 inches and a span of only 8 inches are small. The hands of Orientals are smaller than the average Teutonic hand, and in both cases my own hand has just these measures, which are, therefore, not impossible. Nor is a foot of 10·66 inches unnatural. The *dhrâ'* or "arm," of 26·66 inches, might be thought very short, yet it is an extant measure in Arab metrology (the word itself being Arab), and no existing race is more likely to have preserved Hebrew measures. The stature of a man, 4 cubits of 16 inches, may appear short, yet it is the average of the modern European Jew.

The Jewish palm was of 8 barleycorns. The Egyptian palm was 9 barleycorns.[1] The longer (and, as is supposed, later) Egyptian cubit of about 21·4 inches was the Hebrew cubit of 8 palms, and may have been introduced by Semitic inhabitants.[2] The Egyptian cubit of 6 palms would have measured 17·6 inches. The Rabbinical writers could not have intended such a length, as it supposes a barleycorn 0·37 inch in length, or longer than the largest English barleycorn.

In Ezekiel is mentioned the reed of 6 cubits, of "a cubit and a palm" (Ezek. xl, 5). This is apparently 112 inches, the Arab *ḳaṣab* or "reed" of 108 inches (4 *dhrâ'*), representing the same unit for longer measures.

The cubit used by Josephus was apparently the same as that described in the Talmud. In describing the south cloister of the Temple ("Ant." xv, 11, 5) he, however, uses Greek feet. The measurements agree with the position of the Tyropœon bridge, of which the centre line is 63½ feet from the exterior south-west angle of the Haram. This was made up as below:—

Outer wall	5 feet.
Side cloister	30 „
Pillar	6 „
Half central cloister	22½ „
Total	63½ feet.

[1] With rather lighter barley, about 51 lbs. per bushel.

[2] It represents an Egyptian cubit of the lighter barley (51 lbs. per bushel), measured by corns of the Hebrew barley (53 lbs. per bushel).

The Arab square measure takes as its unit the *kaṣab* of 108 inches. The Hebrew (according to Maimonides, referring to Exod. xxvii, 9, 12) took a measure of 50 cubits square (called *sĕâh*); and of these 30 went to the square *kôr* (75,000 cubits). Thus if the cubit intended is one of 16 inches, the *kôr* measured 3·03 acres, which is about three Arab feddâns (3·3 acres). No people are more likely to have preserved Hebrew measures than the Arabs of the great age of Islam—the seventh century A.D.

Measures of Capacity.

As to measures of capacity, we have even less actual information than in the case of the lengths. From the Rhind Papyrus (Plate XVI) we learn that a cubic cubit contained $1\frac{1}{2}$ *khar*, a unit which was divided into 20 *hekat*, and these again apparently each into 10 *henu*. The *hekat* was consequently the gallon. The various comparisons given by Josephus show the Jewish *bath* or *êphah* to be about 8·4 gallons, which would give a cubic *lôg* of about 32·7 cubic inches. This, however, does not agree with Rabbinical statements. That of Maimonides (on Peah viii, 5) is too indefinite for use, being stated in "thumbs" (of about 0·8 inch); but according to the Mishnah ("Peah" i, 6) the *lôg* was equal to six hen's eggs. These are not likely to have been larger than they now are, and the *log* on this basis could not exceed 24 cubic inches.[1] It is, moreover, stated to have weighed 6,000 grains of water, which gives the same result, and the weights connected with these measures, if taken in barley, are also commensurate. The Egyptian system can be closely compared (*see* Tables) with such an unit; and it results that, if the pyramid barley weighed about 51 lbs. avoirdupois to the bushel, the pyramid coffer, which was 4 Hebrew *kôrs*—cubic measure—in capacity (or 12 *khars*), held 24 talents of corn.

But these two calculations are not of necessity irreconcilable.

[1] This results from measurement of the contents of eggs, which do not exceed 4 cubic inches. It could not have been the original unit, as poultry were unknown before the Persian period. The measurements were made by my father with great care. The statement cannot, at all events, apply to the *lôg* of Josephus. In 1 Kings vii, 38 the smaller bath appears to be intended, if the cubit be 16 inches. On the measurement of eggs *see* Colonel Watson's remarks, *Quarterly Statement*, 1901, p. 203, *seq.* These do not, however, agree with the weight of water in the *lôg*.

The smaller *lôg* may have been the dry measure, the larger the liquid measure, corresponding to the weights of barley and of water respectively. It has been assumed from Ezekiel (xlv, 10, 11) that liquid and dry measure were the same, but the passage refers to an ideal future—as also regarding weights. The proportions of the various Jewish measures of capacity are known, but the actual contents are still variously stated. If we accept the Mishnah as to dry measure, the following results will be noted. First the cube of the 16-inch cubit was 7 *sĕâh* in capacity, and the *bath* occupied a cube of 12 inches, or 36 barleycorns. This approximated closely to the Egyptian measures, obtained from the 20·6-inch cubit. Secondly, the *lôg* held just half a manah of Hebrew barley, or about three-quarters of a manah of water. Thirdly, the *hin* (1·04 gallons) was the Egyptian *hekat* (1·05 gallons). Lastly, the *kor* was equivalent to the Arab *ardeb* very closely (62 to 60 gallons).

If we apply the statement of Josephus to the liquid measure, the *êphah* or *bath* was the cube of the smaller cubit of 13·3 inches, and the *lôg* held a manah of water. The larger measure given by Josephus, and supposed equal to the medimnus or metretes, is 27 Arab *roṭls;* the amphora of Rome (5·6 gallons) being 18 *roṭls.* It is possible, therefore, that this larger liquid measure is of Greek origin, and that originally the smaller alone was used by the Hebrews. The Greek units were probably taken from Phœnicia or Babylon, and may have been early adopted by the Jews. In the absence of any actual discovery of Hebrew measures of capacity, the question of the larger measures rests mainly on their coincidence with the small cubit, and on the weight of water which would thus be measured by the lôg.

Measures of Weight.

In this respect we are much better informed, as we possess actual Babylonian, Assyrian, and Hebrew weights. Considering also that the measures of capacity vary as the cube of the cubit, and that they are again controlled by the weight of barley and of water, definite conclusions may thus be attained, which check the units both of length and of contents.

At Nippur, in Babylonia, a brown hæmatite weight, recently discovered, is inscribed *X TU Zab KUGI dam-kar,* "Ten shekels

of gold of the merchant." The weight is 1,320 grains Imperial, or a little under 133·3 grains for the shekel, so that the gold was weighed by the light Babylonian shekel. Other weights not inscribed represent the same unit (132 grains), and give 5 shekels, half a shekel, the fifth of a shekel, and smaller divisions of the shekel by 60. This weight is that in use about 1500 B.C. or earlier. In later Assyrian weights a slight degradation of the standard is observable, down to about 700 B.C. The following are actual weights of specimens (*see* "Ninth Report of Warden of Standards in 1875"):—

Nineveh (2 manahs 15,984 grains).	Manah	7,992	grains.
Babylon (duck weight 10 manahs).	,,	7,695·7	,,
"Two manahs of the country" ..	,,	15,371	,,
"Two manahs of the king" ..	,,	14,902	,,
Babylonian talent 959,040 grains..	,,	15,984	,,
Lion weight Nineveh, 30 manahs. (700 B.C.)	,,	7,776·6	,,
Lion weight Nineveh, 15 manahs. (700 B.C.)	,,	15,364·2	,,

The manah was a sixtieth of the talent, and taking the oldest and heaviest examples, we obtain in round numbers:—

Heavy manah, 16,000 grs. Imp. = talent, 960,000 grs. Imp.
Light ,, 8,000 ,, = ,, 480,000 ,,

There is no evidence that the manah of Babylon was ever divided into other than 60 shekels, whereas the Hebrews (Exod. xxxviii, 25) divided into 50 shekels. Nor is there any evidence that gold and silver were weighed by standards different from each other, or from copper or other things weighed. The whole system of Babylon and Assyria was based on the above units. The Babylonian heavy shekel was thus about 266·6 grains in weight, represented at Nippur by an actual weight of 264 grains. Hence the Hebrew shekel—if the manah was of the same weight—would have been 320 grains.

This deduction is supported by the two independent discoveries of Hebrew weights—one at Samaria marked *reba' Sh-l*, "quarter shekel" of 39·2 grains (for 40 grains), and also marked *reba' neseph* (*i.e.*, "quarter half," as explained by M. Clermont-Ganneau), being the quarter of the light shekel of 160 grains;

the other from Tell Zakarîya marked *neṣeph*[1] ("half"), and weighing 154 grains (for 160); both these discoveries agree with the statement of Maimonides (on "Shek." i, 2) that the original Hebrew shekel weighed 320 grains of barley.

Phœnician shekels of the Persian age, however, are found (by Dr. Flinders Petrie) weighing up to 235 grains. These are probably the three-quarter shekel of 240 grains as used at a later period. According to Maimonides after the Captivity the shekel was increased to 384 grains. It then coincided with the tetradrachm of the old system used by Greeks at Ægina, and was also brought into accord with the Persian gold *daric* of 128 grains. The Greeks of Attica, after 600 B.C., adopted a shekel of 266·6 grains from Assyria; and in the second century B.C. the Jewish weights seem to have been brought into accord with this system, adopting a shekel of 222·2 grains (actual coins being 220 and 110 grains), which gave 30 shekels to the Greek manah. None of these facts are therefore irreconcilable. The statement in Ezekiel that in future 25 and 20 and 15 shekels should be the manah (xlv, 12), means apparently that the weight of the shekel was to be doubled. Thus:—

			Shekel.
Heavy shekel	320 × 15 = 4,800	light manah ..	Hebrew.
,, ,,	240 × 20 = 4,800	,, ,, ..	Phœnician.
,, ,,	192 × 25 = 4,800	,, ,, ..	Greek.

Maimonides refers to this later manah of 100 to the talent (on Keritoth), as consisting of 100 *dinars*, each of 6 drachmæ, each of 16 grains of barley. This drachma was thus a sixth of that of Ægina (the pondion doubled or 32 Roman *as*), the grain of barley being the Imperial grain.

From the table showing the dimensions and weight of barley it will be seen that a grain 0·33 inch in length weighs an Imperial grain, giving a carat of 3 grains, as against English barley of 1·06 grains Imperial, giving the modern carat of 3·18 grains. Hebrew barley weighed therefore 53 lbs. avoirdupois to the bushel, and 4,000 grains were measured by the *lôg* of 24 cubic inches. The Arab carat of 2·97 grains is derived from the lighter barley of 50 lbs. to the bushel. This gives the old *dhrâ'* of 26·6 inches,

[1] The vowel sounds are, of course, somewhat conjectural, but this does not affect the translation.

and the *dirhem* of 47·7 grains for the half drachma (48 grains), with the *ardeb* of 60 gallons to the Hebrew *kôr* of 62 gallons. The measures of weight capacity and length are thus in exact accord, and agree with actual weights and measures. Comparing the various weights thus ascertained with literary statements, and with existing Greek coins, we find that the new Attic talent (of Solon after 600 B.C.) was to the Babylonian as 5 to 3, or as 800,000 grains to 480,000 grains. The old talent of Ægina and Macedon was the Babylonian, and was as 6 to 5 to the Euboic talent of 400,000 grains. The Roman libra of 5,000 grains multiplied by 80 gave the talent then used in Egypt, which was the later Greek talent of 400,000 grains.[1] Herodotus (iii, 89) gives 70 Euboic minæ to the Babylonian talent. This gives 466,666·6 grains to the talent. The contemporary Persian talent had been even more depreciated from the old Babylonian (to about 460,800 grains); and, as above given, the weights (of about 700 B.C.) give the lighter talent at 479,520 grains, and 462,830 grains by gradual depreciation of the standard. Ælian gives the full weight (72 Greek minæ or 480,000 grains); Pollux (ix, 86) agrees with Herodotus (7,000 Attic drachmæ of 66·6 grains); Plutarch's statement (Solon 15), compared with the extant Greek weights, gives the following:—

	Drachma.		Mina.		Talent.		
Ægina ..	96	×	100	×	50	=	480,000 grains.
Euboic ..	92·6	×	72	×	60	=	400,000 ,,
Attic ..	66·6	×	100	×	60	=	400,000 ,,

The Ægina coins give 96 grains for the drachma, the new Attic give 66·5 grains (as given in Sir C. Warren's paper); but the Ægina talent of 10,000 Attic drachmæ (Pollux ix, 76) must refer to the old Attic drachma (92·6 grains), and represents a degradation of the light talent to 463,000 grains.

The statement of Josephus ("Ant." xiv, 7, 1) that a mina of gold was $2\frac{1}{2}$ *litrae* has been assumed to refer to the Roman libra. It more probably refers to a slightly depreciated Greek mina, giving 16,000 grains for the mina, and 6,400 grains for the litra. The

[1] The bronze lion from Abydos in the Troad weighs nearly 57 lbs. (or 399,000 grains), representing this talent about the beginning of the fifth century B.C. The Aramean text is read, "Verified before the supervisors of Silver" (*see* Taylor, "Alphabet," I, p. 257).

Persian shekel (about 500 B.C.) was 128 to 130 grains (depreciated from the old Babylonian 133·3 grains), and the manah thus 7,680 for 8,000 grains, or double this for the heavier system.

The command in Deuteronomy (xxv, 13, 14) forbids a "great and small" weight or measure. It refers probably to the double system of Babylonia,[1] and perhaps to the double system of dry and liquid measure (*lôg* of 24 and of 32·7 cubic inches); but, if any difference was made in weighing gold and silver, it must have been that gold was weighed by the *neṣeph* or "half" system, and silver by the heavier system; for we find at Nippur gold so weighed. In our own time we use the same weight for both metals, and there is no proof of the existence of separate standards for the metals, if we take into consideration the gradual degradation of the standard in time, and the varying values of silver and gold as compared together.[2]

Measures of Value.

The question of value, rendered easy by the existence of Jewish, Greek, and Roman coins, is on the other hand complicated by the consideration of the comparative fineness of the silver and gold, and of the relative values at different times. Actual coins are not traced before the seventh century B.C.; but about 500 B.C. the gold daric weighed about 128 grains, and was rather less alloyed (by one twenty-fourth) than our sovereign. The silver daric weighed about 86 grains, and the value of gold was about $13\frac{1}{2}$ times that of silver. The debased silver of the East is now reckoned at about 19 to 1 of gold, as against our 15·5 to 1. The old Hebrew and Babylonian proportion seems clearly to have been close on 16 to 1. The silver daric, reduced to this proportion, is equal to the shekel weight of about 100 grains for the drachma. It was called a "shekel," and its then value agrees with the statement of Xenophon that it was equal in value to $7\frac{1}{2}$ Attic oboli, or about $12\frac{3}{4}$ pence.

In the attached tables, for comparative purposes, the value of gold is taken as 16 times that of silver, as representing early silver.

[1] This double system, however, continued late, and according to the Mishnah it appears that the shekel of Galilee was half that of Jerusalem in the second century A.D.

[2] If the weights found at Troy are to be compared with the Babylonian system they represent a manah of 7,992 grains, and are therefore early.

Maimonides (on "Shek." i, 2; v, 6; xi, 4) gives the old shekel as 320 grains, but states that after the Captivity it was increased by a fifth to 384 grains. He probably founded this on Ezekiel (xlv, 12); but the statement is probable, since it makes the Jewish coinage coincide with that of Ægina, and with that of Persia, reduced to silver of the proportion 15 to 1 of gold. The parallel systems are as follows:—

Ægina.		Palestine.		Persia.		Value.	
	gr.		gr.		gr.	*s.*	*d.*
Drachma	96	Zuza ..	96	1 Siklos* ..	96	1	0
Didrachma	192	Tib'a ..	192	2 „ ..	192	2	0
Tridrachma.. ..	288	Rigia ..	228	3 „ ..	288	3	0
Tetradrachma ..	384	Sela† ..	384	4 „ ..	384	4	0

The Persian siklos being at the rate of $13\frac{1}{3}$ to 1, silver to gold, actually weighed about 86 grains, but the older silver was less pure. The original manah standard of this age had been reduced gradually from 8,000 to 7,680 grains. Hence the old three-quarter of the light Babylonian shekel (100 grains) was made the lowest unit as 96 grains. This system survives in our troy weight, 96 grains being 4 pennyweights (24 × 4).

The Phœnicians appear about this period (judging from weights of about 235 grains actual) to have either preserved the old Hebrew shekel of 320 grains, or to have used the three-quarter shekel of 240 grains as their unit; but within the Persian period they had further reduced their shekel to about 220 grains (or perhaps allowing for loss of weight, 222·2 grains), whereby their coinage became measurable by the Attic system: for 30 shekels

* The *siklos* thus reduced is the tridrachm of the light weight system, with the light manah of 7,680 grains, used in the Persian ages (compare the Babylonian duck-weight 7,695·7 grains to the manah, probably later than the seventh century manah of 7,776·6 grains). The later Phœnician and Jewish manah (one-fifth more than the old Hebrew) contained 100 such tridrachms. The Persian manah contained 80, that is 30 tetradrachms of the heavy system. The manah of 7,680 grains divided by 60 was the daric of 128 grains. The heavy daric was 256 grains (as in extant coins of the so-called double daric). Of this weight, representing a third of *sela*, 15 went to the light gold daric and 30 to the heavy, with silver as 15 to 1 gold.

† If the ratio of the silver of this system was 15 to 1, 5 *sela* went to the daric of 128 grains gold.

thus went to the Attic mina (6,666·6 grains); and this semi-Greek system is that of the Hasmonean silver coins, which actually weigh 220 grains for the shekel, 110 for the half shekel, and 55 for the quarter shekel.

In the Mishnah ("Shekalim") the value of the half shekel (Exodus xxx, 13) is discussed. The priests (*see* Buxtorf, "Lex," s.v. *Rigyâ*[1]) demanded the *ṭib'a*, the people offered the *zûzâ*, and finally as a compromise the "Shekel of the Sanctuary" was fixed at the *rigiâ* or 228 grains—114 grains for the half shekel. This was represented as early as the second century B.C. by the half shekel of 111·1 grains, due to the slight depreciation of the standard.

The Roman system appears to have been founded on the Babylonian or Attic, not on the western—Phœnician and Hebrew—division of the manah by 50; if we take into consideration the gradual refining of silver. Thus the Babylonian quarter shekel of 66·6 grains is represented by the denarius of 60 grains, the silver being improved from a ratio of 16 to 1 of gold, and giving 25 denarii to the aureus, or about 12 to 1 for silver as compared with gold.

It must be remembered that the coinage of silver only was allowed by the Greeks and Romans to cities, the gold unit being that of the ruling nation. Thus we have no Jewish gold coins, and in the Persian age the gold unit was the daric, as stated by both the Bible (Neh. vii, 70) and Josephus ("Ant." iii, 8, 10). The Jews were allowed by the Seleucidæ to coin silver (1 Macc. xv, 6); and, as we have seen, by a reduction in weight from 228 to 222·2 grains, their coinage was made to coincide with the Greek, while agreeing pretty closely with the required weight for the Temple tribute. For copper the Hasmoneans appear to have retained the old Hebrew and Phœnician unit: for the copper shekel of Simon weighs 156 grains (for 160 grains), and is very commonly found.[2]

As regards "coins of the revolts" nothing need here be said, as probably Renan is correct in regarding those stamped on Roman denarii as forgeries, the genuine examples being of the Hasmonean age.

[1] The preferable spelling is *ragyâ*.

[2] The weight found by R. P. Cré at Jerusalem, which he believes to be a talent, is about 646,615·46 grains, which would give a shekel of 215·5 grains. The inscription is so doubtful that it can not be considered certain that it is Hebrew at all.

Results.

The results which appear to follow from the preceding calculations are:—

1. The Hebrew barleycorn weighed 1 Imperial grain, and was 0·33 inch in length (53 lbs. per bushel).
2. The cubit of 6 palms was therefore 16 inches in length.
3. The Hebrew dry measure was based on a *lôg* of 24 cubic inches, giving 7 *sĕâh* to the cubit of 16 inches.
4. Jewish liquid measure (perhaps of a later period) was based on the smaller cubit of 13·33 inches, the cube being the *bath*.
5. The Hebrew and Babylonian manah was the same, but divided by 60 in Babylonia and by 50 among Hebrews for the shekel; and the Hebrew shekel was consequently 320 grains.
6. Jewish coinage in the second century B.C. was made to agree with the Greek. In the Persian age it agreed with that of Persia, and before the Captivity with that of Assyria, coins, however, not being as yet stamped.

APPENDIX.

Since the above was written Mr. A. E. Weigall has contributed an interesting paper to the "Proceedings of the Society of Biblical Archæology," December, 1901, pp. 378–395, on weights found in Egypt, which not only confirms what has been said above, but also serves to show that extreme accuracy cannot be attained when a large number of weights are compared. Some of the specimens—scarabs, &c.—may be only ornaments not of exact weight, but out of 100 objects described a fair proportion bear numerals, showing them to be actual weights. They belong to various systems, native Egyptian, Babylonian or Assyrian, Phœnician, Persian, and Greek.

The average weight of specimens of the Egyptian *Kat* unit is 144 grains. This appears to be three-fifths of the old Phœnician shekel of 240 grains. The weights marked as used for weighing gold give an average of 202 grains, representing three-fourths of a Babylonian shekel (200 grains).

As to the foreign weights, the average for the Phœnician shekel is 222 grains, representing the later shekel used about the fifth century B.C., with the lighter talent of 400,000 grains (as at Abydos in the Troad). The heaviest specimen (No. 7,081), weighing 234·8 grains, seems, however, to represent the older unit of 240 grains.

The average weight of the unit supposed to be Assyrian is 126·5 grains. This represents the manah of about 7,600 grains, and indicates a late period, after the conquest of Egypt by Assyria in 680 B.C. There is, however, a specimen (No. 7,002) of a light manah 7,926·5 grains, which is probably much older. Specimens from Tyre (No. 7,047) and from Smyrna (No. 7,049) represent three-fourths of the Babylonian shekel, or 200 grains, as an unit. The Persian siglos of 86 grains, the Ægina drachma of 96 grains, and the Euboic of 92 grains, are also represented, while the mean weight of the Attic drachma is 133 grains.

I.—COMPARATIVE TABLE OF BARLEYCORNS.

——	English.	Hebrew.	Arab.
Weight of bushel	56 lbs.	53 lbs.	50 lbs.
Weight of one corn	1·05 grs.	1 gr.	0·99 gr.
Weight of carat (3 corns)	3·18 grs.	3 grs.	2·97 grs.
Cubic bulk of a corn	0·037 in.	0·035 in.	0·032 in.
Length of a corn	0·35 in.	0·33 in.	0·32 in.
Width of a corn	0·117 in.	0·114 in.	0·112 in.
Thickness of a corn	0·095 in.	0·094 in.	0·093 in.
Weight of pint	6,125 grs.	5,800 grs.	5,469 grs.
Weight of lôg	4,426 grs.	4,000 grs.	3,941 grs.
Number of corns in pint (actual) ..	5,342 corns	5,800 corns	6,344 corns
Number of corns in pint (mathematical)	9,121 „	9,900 „	10,833 „
Number of corns in lôg (actual) ..	3,684 „	4,000 „	5,625 „
Number of corns in lôg (Warren) ..	3,653 „	3,966 „	5,320 „

Data.

Weight of distilled water in lôg (24 cubic inches) ..	6,055 grains.
„ „ „ pint (34·66 cubic inches) ..	8,744 „
„ „ „ bushel	80 lbs. avoir.
„ one corn English barley (deduced)	1·05 grains.
„ „ Hebrew „ „	1·00 grain.
„ „ Arab „ „	0·99 „

II.—HEBREW DRY MEASURE.

English.	cubic ins.	grs. barley.	weight. barley.
0·69 pint (lôg)	24	4,000	⅙ manah.
2·76 pints (cab)	96	16,000	2 manahs.
5 pints (omer)	172·8	12,533	
2 gallons (seah)	576	96,000	12 manahs.
6·2 gallons (ephah)	1,728	288,000	36 manahs.
7·5 bushels (kor)	17,280	2,880,000	6 talents.

III.—Comparative Table of Measures of Capacity.

Dry Measure.

Lôg of corn = ⅓ manah. Bath or ephah, ⅔ cubit of 16 inches cubed.

——	Hebrew.		Egyptian.		Roman.		Arab.		Notes.
	cub. in.	pint.		pint.		pint.		pint.	
Lôg	24 ..	0·69	1 Henu ..	0·8	⅙ Choas ..	0·7	3 Ukieh ..	0·63	6 hen's eggs, 24 cubic inches (*see* Peah i, 6).
Cab	96 ..	2·76	3 „ ..	2·4	½ „ ..	2·8	Rotl ..	2·5	
Omer.. ..	172·8..	4·96	6 „ ..	4·8	1 „ ..	5 6	2 Rotls .	5·0	
		gall.		gall.		gall.		gall.	
Hin	288 ..	1·04	1 Hekat ..	1·05	½ Modius ..	0·94	3 „ ..	0·94	The hin is the gallon.
Seah	576 ..	2·08	2 „ ..	2·1	Modius ..	1·88	6 „ ..	1·88	7 seah the 16-inch cubit cubed.
Ephah ..	1,728 ..	6·2	6 „ ..	6·3	Amphora ..	5·6	18 „ ..	5·6	20 Rotls = 6·2 gallons.
Kor	17,280 ..	62·0	3 Khar ..	63·0	½ Culeus ..	56·0	Ardeb ..	60·0	16 dubbeh = 62 gallons.

III.—Comparative Table of Measures of Capacity—(*continued*).

Liquid Measure.

Lôg of water = a manah. Bath or ephah, a cubit of 13·4 inches cubed.

——	Hebrew.		Roman.		Attic.	Notes.
	cub. in.	pint.		pint.		
Lôg	32·7..	0·81	Sextarius ..	0·94	Xesta	"Ant." viii, 2, 9; 72 xestæ = 1 bath.
Cab	130·8..	3·24	4 Sextarii ..	3·76	4 Xestæ	48 sextarii = 1 amphora.
Omer	236 ..	6·7	7 Sextarii ..	6·58	7 Cotylæ	"Ant." iii, 6, 6; 7 Attic cotylæ = 1 omer.
		gall.		gall.		
Hin	393 ..	1·4	2 Choas ..	1·39	$\frac{1}{6}$ Medimnos ..	"Ant." iii, 8, 3; 9, 4; 2 Attic choas = 1 hin.
Seah	785 ..	2·9	1½ Modii ..	2·8	$\frac{1}{3}$,, ..	"Ant." ix, 4, 5; 3 modii = 2 seahs.
Ephah	2,353·6..	8·4	Metretes ..	8·4	1 ,, ..	The metretes, 1½ amphoræ of 1,581 cub. ins.
Kor	23,526 ..	84·0	10 Metretes ..	84·0	10 Medimni ..	"Ant." xv, 9, 2; 10 Attic medimni = 1 kor.

Note.—The coffer in the Great Pyramid (72,000 cubic inches) held 3,000 dry measure lôgs, or 1,500 manahs Hebrew barley (25 talents). If the barley weighed 51 lbs. average per bushel it contained 24 talents (4 kor Hebrew measure, 12 khar Egyptian = 4 measures).

The Egyptian cubic cubit of 20·6 inches held 1½ khar.

The Hebrew cubic cubit of 16 inches held 7 sĕâhs (dry measure).

IV.—Comparative Table of Weights.

(1 cubic cubit of 16 inches = 8 manahs, gold.)

—	Hebrew.	Babylonian.	Phœnician.		Persian.	Ægintine.	Euboic.	Attic.	Roman.	Arab.
	grains.	grains.	grains.	grains.	grains.	grains.	grains.	grains.	grains.	grains.
Quarter shekel	80	66·6	60	55·5	64	96	92·6	66·6	50	47·7*
Half shekel	160	133·3	120	111·1	128	192	185·2	133·3	100	—
Three-quarter shekel ...	240	200	180	166·6	192	288	277·8	200	150	143†
Shekel	320	266·6	240	222·2	256	384	370·4	266·6	200	—
Manah	8,000	8,000	9,600	6,666·6	7,680	9,600	6,666·6	6,666·6	5,000	9,540‡
Manah	16,000	16,000	—	—	15,360	—	—	—	—	—
Talent	480,000	480,000	—	400,000	460,800	480,000	400,000	—	400,000	—
Talent	960,000	960,000	960,000	—	921,600	—	—	800,000	—	686,000§

* The dirhem. † Quarter okich. ‡ Half oka. § Kantar.

V.—Comparative Table of Values.

(Silver to gold 16 to 1.)

—	Hebrew.	Babylonian.	Phœnician.	Persian.	Jewish.	Ægintine.	Euboic.	Attic.	Roman.	Arab.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Quarter shekel ...	0 0 10	0 0 8½	0 0 7½	0 0 8	0 0 7	0 1 0	0 0 11½	0 0 8½	0 0 6¼	0 0 5½
Half shekel	0 1 8	0 1 5½	0 1 3	0 1 4	0 1 2	0 2 0	0 1 10½	0 1 5½	—	—
Three-quarter shekel...	0 2 6	0 2 1½	0 1 10½	0 2 0	0 1 11	0 3 0	0 2 10	0 2 1½	—	—
Shekel	0 3 4	0 2 10	0 2 6	0 2 8	0 2 4	0 4 0	0 3 9	0 2 10	—	—
Manah silver	4 3 4	4 3 4	5 0 0	4 0 0	3 8 6	5 0 0	3 8 6	3 8 6	3 2 6	4 19 3
Manah silver	8 6 8	8 6 8	—	8 0 0	—	—	—	—	—	—
Talent	250 0 0	250 0 0	—	247 10 0	—	250 0 0	218 6 4	—	—	—
Talent	500 0 0	500 0 0	500 0 0	495 0 0	—	—	—	436 12 8	—	—
Manah gold	66 13 4	66 13 4	80 0 0	64 0 0	—	80 0 0	55 1 0	55 1 0	41 13 4	79 5 0
Manah gold	133 6 8	133 6 8	100 0 0	128 0 0	—	—	—	—	—	—
Talent gold	4,000 0 0	4,000 0 0	—	3,840 0 0	—	4,000 0 0	3,334 0 0	3,334 0 0	—	—
Talent gold	8,000 0 0	8,000 0 0	8,000 0 0	7,680 0 0	—	—	6,668 0 0	—	—	—
Gold unit	1 0 10	1 0 10	—	1 1 0	—	—	—	0 18 0	1 1 0	0 18 0