

## WEIGHTS FOUND IN JERUSALEM.

CONSIDERATION OF THE ANCIENT SYSTEM OF WEIGHTS, SHOWING THE DERIVATION OF THE STONE WEIGHTS FOUND IN THE EXCAVATIONS AT JERUSALEM IN 1867-1870, AT OPHEL, ROBINSON'S ARCH., &c. (*P.E.F.Q.S.*, 1870, p. 336).

(*Concluded from Q.S.*, p. 190.)

By General Sir CHARLES WARREN, G.C.M.G., K.C.B., F.R.S., R.E.

## (4)—THE FOUR ANCIENT SYSTEMS OF WEIGHTS AND MEASURES.

I will now give a brief summary of the progress of our weights and measures since early times, down to the 3rd or 4th century B.C.

There have been four principal systems of weights and measures :—

1. The original weight system; traces of which can be found at the present day in India, which will not be further alluded to.
2. The binary and decimal system, usually called Egyptian or Euboic.
3. The duo-decimal system, used in Egypt and Assyria and called Eginetan.
4. The sexagesimal system, used in Southern Babylonia and Persia and brought into Europe by the Phœnicians, which we may call Gudean.

These have all emanated from the content of the old cubit cylinder of 24 digits, or from the old double cubit (28 digits) cubed, which bear to each other the ratio of 1 : 4.

Systems 2 and 3 are closely connected, in that 32 cubit cylinders (Euboic talents) are equal to 27 Babylonian talents or cubic feet.

In the Euboic system 2,564 Hon of 6,750 O.G.T. are equal to 2,160 Log (Eginetan) of 8,100 O.G.T., the content of the double

cubit cubed. The number of grains totalled out are, Euboic 17,280,000, Eginetan 17,469,000; so that it is evident either that the grains were unequal if the double cubit was the same, or that the double cubit differed if the grains were equal in weight, the difference being as 80 : 81. This difference arises principally from the Euboic system discarding, as has been shown, 128 Rati from the 5,128 Rati forming the pint, so as to arrive at the number 5,000 Rati. The difference in practice, however, is so small that 27 Hon would exchange for 20 Log, and the shekels and Kats of both systems were interchangeable.

The principal weights used in Europe and Asia have been in connection with these two systems, viz. :—the shekel, the ducat, the Tower pound, and the Hon of 6,750 O.G.T., suppressed in England in 1325 A.D.:

For measures of capacity the Euboic system gave our cylindrical measures (bushels, etc.), while the Eginetan system gave the Hebrew Bath and Log measures, which appear in Greece and Italy subsequently as Metretes, Congius and Sextarius measures.

The 4th or Gudean system was on a different footing to systems 2 and 3, and seems to have been confined for many centuries to Southern Babylonia and Persia, and possibly Syria, until perhaps the 6th century B.C., when it developed under the Persian supremacy and subsequently spread over the Levant, in the hands of the Phœnicians.

It is, in its later form, strictly on the sexagesimal basis. Six-sevenths of the contents of the double cubit cubed (60,000 cubic inches) were divided into a 1,000 parts to form the double mina of 60 cubic inches, and the mina was divided into 60 parts, cubic inches or shekels. Each shekel was divided into 180 parts, *shé* or grains.

The talent was 60 double mina or 3,600 cubic inches. The cubic foot had not been introduced in those days, so that the date of this system appears to have been after the introduction of the double cubit cubed, but before the establishment of the cubic foot.

There were then  $1,166\frac{1}{3}$  double mina to the double cubit cubed and 43.2 double mina to the cubic foot, so that it is not readily connected up with the other two systems; but 10 Tower pounds (5,400 O.G.T.) equalled 9 Gudean single minas of 7,500 O.G.T.

In the Euboic and Eginetan systems the Tower pound, Hon and Log, when taken together, are in the ratio of 4, 5, and 6 by weight,

but when the Gudean single mina is added in, the ratios are 36, 45, 54, and 50.

It is desirable to ascertain whether the double mina of Gudea can be referred to the other ancient systems by means of its grains.

All the minas and pounds of systems 2 and 3 can be expressed in whole numbers of ancient grains at the rate of 9 Troy grains to 8 ancient grains. Thus the Tower pound (5,400 O.G.T.) becomes 4,800 A.G., the Hon (6,750 O.G.T.) becomes 6,000 A.G., and the Log (8,100 O.G.T.) becomes 7,200 A.G., but the Gudean mina (7,500 O.G.T.) is intractable and becomes 6,866·6 A.G., and no relation can be found for practical purposes between 6,866·6 and 10,800 (the number of *shé* in the mina). If 300 grains are taken to the cubic inch instead of 180, it is not much improved.

Now it is quite evident that when the Gudean mina was brought into the Levant, the sexagesimal system of calculation by  $60 \times 60 \times 180$  would be too laborious in countries where calculations by tens and twelve were in vogue, so that if the Gudean system was to be used some compromise must be effected. But we know that this weight was used extensively, and we have to find out how calculations were made possible.

Now the Eginetan system gives  $222\frac{2}{9}$  ( $= \frac{2000}{9}$ ) grains to the cubic inch, while the Gudean system has the cubic inch as a shekel, but the Gudean system could not adopt the Eginetan number of grains. It is seen that the fraction of the Eginetan number of grains to the cubic inch has 9 as a denominator; what could be more simple, for a compromise, than to divide the ancient grain by 8 and multiply by 9, and thus get rid of the fraction, giving 250 grains to the cubic inch,  $\frac{2,000}{9} \times \frac{9}{8} = 250$ , and at the same time in order to get rid of the excess of the number 3 and for other reasons, to increase all the pounds by  $\frac{1}{3}$  of their weight. But the further consideration of this subject must be reserved for what has to be said concerning the Gudean shekel.

#### (5)—THE GUDEAN SHEKEL.

On the sitting statue of Gudea found at Telloh (Larsa), in Southern Babylonia, probably contemporaneous with the IVth

Egyptian dynasty, there is a cubit scale cut on the hard stone with great care. There are 16 divisions shown, 63 of which equal the length of the double cubit of the Great Pyramid, and 60 of which form the cubit of Gudea = 39.276 inches (39.211 according to Professor Kennedy).

This double cubit cubed equalled 60,000 cubic inches, and contained 1,000 double minas of 60 cubic inches each. The weight of a cubic inch of water being a shekel weight, and the double mina weighing 15,000 O.G.T.

The weight of the double mina is given by Professor Kennedy,<sup>1</sup> from actual testing as 15,160 G.T., which deducting 1 per cent. gives 15,010 O.G.T.

The weights found are said to have existed at least 2000 years B.C. There is also in the Early Temple accounts at Telloh (dating back at least 2000 B.C.), an account of a subdivision of the shekel (weighing one cubic inch of water) into 180 *shé* or grains of wheat, a subdivision subsequently discarded. Thus we have good reason to suppose that the cubic inch shekel goes back at least to the time of Gudea, in Southern Babylonia. And as Elam and Persia came under the influence of the Accad monarchs, we may assume that this Gudean system may have come into use in Persia at an early date.

Again, we know from the coins of the Persian kings, dating as far back as 518 B.C., that the gold darics weighed two to a cubic inch of water, and that the silver siglos weighed three to a cubic inch of water or Gudean shekel, and the daric of the Lydian kings, dating as far back as 560 B.C., have the same weight.

It is evident that the Gudean shekel had not altered up to the end of the Persian supremacy.

Again, in later times we have the Olympic standard in Greece, of which the pound was the single mina of 7,500 O.G.T. or 30 cubic inches of water.

We have testimony also that the Persian daric had an extensive circulation in Greece (Xen. *Anab.*, i, 3). These coins are supposed also to have been struck in Egypt during the reign of Cambyses of Persia; and there is evidence that the shekel weight of a cubic inch of water was in use amongst the Phœnicians after the Persian supremacy was overthrown.

<sup>1</sup> "Weights and Measures," Hastings, *Dict. Bib.*

We have then good reason for supposing that the Gudean single mina of 7,500 O.G.T., and the shekel of 250 O.G.T. were extensively used in the Levant up to the time of the Ptolemies and Seleucidaë.

We have, moreover, the Roman pound during the Consuls weighing 5,000 O.G.T., probably  $\frac{2}{3}$  of the Gudean pound, and we have the same pound in use in the Greek States in Asia Minor, during the Early Roman period.

(6)—THE EGYPTIAN KAT.

We have now to consider the subject of the Egyptian Kat, which in early times was 136 G.T., but in later years increased in weight to 145.4 G.T., and has come down to us in late times in the Cairo Moslem Rotl of 6,912 O.G.T., or 48 Kat of 144 O.G.T.

We may trace the existence of this Kat of 40 to the Troy pound up to recent times.

Kelly's *Cambist* (1824) tells us of the Cairo ounce of 576 G.T., which equals 4 Kat of 144 G.T.

Dr. Arbuthnot, 100 years ago, tells us of the Rotl of Cairo of 144 drams of 48 G.T., which is 48 Kat of 144 G.T.

Professor Greaves, 250 years ago, tells us the same of the Alexandrian Rotl.

Quiebo cites Makrisi and Mahomed Sephad (of VIIth century), to show that the Moslem pound was 144 drams of 64 grains (64 grains = 48 G.T.).

We have here again an indication of the transformation that took place :

	O.G.T.		O.G.T.
The Kat	135	raised by $\frac{1}{15}$ to	144.
Tower pound	5,400	„ „	5,760 = 40 Kat, Troy pound.
Attic „	6,480	„ „	6,912 = 48 Kat, Cairo Rotl.

The question now arises as to when this change took place. At present, we only know of the Troy pound, so far back as the time of Khalif Al Mamun, 814 A.D.

(7)—THE ADDITION TO THE OLD POUNDS OF  $\frac{1}{15}$  THEIR WEIGHT (Table I and II).

I give two tables. No. I shows how the old pounds of 6,750 O.G.T. (the Hon), 5,400 O.G.T. (the Tower pound), and 6,480

O.G.T. (the Attic pound), have been raised by  $\frac{1}{15}$  together with their commercial relatives the pounds of 16 oz., and the parts of Europe they were common to before the introduction of the metrical system.

It will be seen from the table that the raised pounds have only been found in the civilised world of the Roman period, while the old pounds have been found amongst the Gothic or Barbarian races, and that there are further distinctions.

North of a line drawn from the mouth of the Elbe through Holland, Switzerland, to Venice, the old pounds were to be found. South of this line were to be found the raised pounds. But the Tower pound had its habitat in Germany and Northern Italy, while the Attic pound was found in Poland, West Austria, and West Russia, suggesting two distinct races or kingdoms.

South of the line the Troy pound was found in France, Holland, part of Switzerland, and North Italy, while the Roman pound was found in Southern Italy, up to Florence, Rome, Spain, and Portugal.

It might be reasonable to assume from this that the change was made under the Roman Emperors, were it not that there is another method by which some of these pounds may have been arrived at, which I show in Table II, viz.: by taking for the pound, 96 drachmas instead of 100 of the old pound. This, however, we may be certain of as having taken place when Rome became intimately acquainted with the Measures of Egypt, between 150 and 50 B.C. It may be, perhaps, safe to assume that the adoption of the raised Tower pound making the Troy pound took place throughout the Roman Empire about 50 B.C., but this is no indication of the time when the raising took place in Egypt or Persia, which may have occurred centuries before.

#### THE MINA OF 8,000 G.T. AND 80 G.T. STANDARD.

We have now another clue to the raising of the old pounds by  $\frac{1}{5}$  of their weight.

It will be seen in Table I that the Persian pound of 7,500 O.G.T., when raised by  $\frac{1}{5}$  its weight, becomes 8,000 O.G.T., and it will be seen from Table II that a pound of 8,000 O.G.T. cannot have been arrived at by taking 96 drams of any known pound, that it cannot be turned into a pound of ancient grains, and that it is altogether

irreconcilable with the pounds derived from the double cubit cubed, except by deriving it from the Gudean single mina. It is therefore not an ancient pound, but has come into existence some time before 50 B.C. How long before we have no certainty as yet, but it is hoped that the Jerusalem weights will lead us up to the clue.

We have the following weights, said to be of 700 B.C., which seem to be of the 8,000 O.G.T. pound:—

	G.T.	O.G.T.	O.G.T.
700 B.C. Nineveh 2 Maneh .. .. .	15,984	15,834	166 16,000
Babylonian Talent, 95,904 O.G.T.	15,984	15,834	166 16,000
Naukratis, several Petrie 80-grain standard	..	..	8,000

Thus it appears that the raising of the pound 7,500 to 8,000 O.G.T. may have taken place in Babylonia as early as 700 B.C. and in Egypt somewhat later.

TABLE I.

To show how the original mina and pounds have at some period been raised by adding  $\frac{1}{15}$  of their weight, at the same time that the weight of the grain was changed from  $\frac{2000}{9}$  to 250 to the cubic inch.

—	Rati.	Ancient Grains.	Old Grains Troy.	Old Grains Troy raised $\frac{1}{15}$ .	Ounces in pound.	Remarks.
I	32	48	54	—	—	The Ducat, Quarter Shekel, Purana.
II	80	120	135	144	—	The Kat or Kharsha.
Euboic ... III	4,000	6,000	6,750	7,200	—	Moslem Miscal Rotl.
IV	—	8,000	9,000	9,600	—	See Naukratis and Taxis.
IV	3,200	4,800	5,400	—	12	Tower pound. All Germany, England, Denmark. E. Switzerland, N.E. Italy, including Venice.
Half Eginetan	—	—	7,200	—	16	Troy pound. France, England, Holland, W. Switzerland, N. Italy to Turin.
Mina ... V	—	—	5,400	5,760	12	
VI	—	—	7,200	7,680	16	Solonian pound. Poland, W. Austria, W. Russia.
VI	—	—	4,860	—	12	
Attic Mina ...	—	5,760	6,480	—	16	Roman pound. Spain, Portugal, South Italy, Rome and Florence.
VI	—	—	4,860	5,184	12	
VII	—	—	6,480	6,912	16	The Moslem Cairo Rotl.
VIII	—	—	—	6,912	—	The Gudean single Mina.
VIII	—	—	7,500	—	—	Babylonia.
VIII	—	—	7,500	8,000	—	80 standard. Naukratis, Babylon, Nineveh.

The Troy pound is the Rotl of the Khalif Al Mamum of Bagdad, A.D. 814.

TABLE II.

To show how the pounds raised by  $\frac{1}{15}$  of their weight may also have been obtained from other pounds by lowering them from 100 to 96 drachmas.

A.G.	O.G.T.		Distribution.	O.G.T.		C.I.
	100.	Lowered 96.		Raised 16.	15.	
4,800 —	5,400 7,200	—	{ $\frac{1}{2}$ Babylonian Mina. North of line of Roman civilization in Middle Ages.	—	5,400 7,200	{ 1,728
4,800 —	5,400 7,200	5,184 6,912		{ Roman pound. Spain and Portu- gal, S. Italy, Rome, Florence.	5,184 6,912	
— — —	4,860 6,480 6,480	— — 6,220.8	{ Attic Mina. Poland, W. Austria, } W. Russia. Pound of Seleucidæ in Persia ...	— — Nil	4,860 6,480 —	{ Attic.
— — — —	— — 6,000 8,000	— — 5,760 7,680	{ Naukratis. Babylonia ... } { Troy Pound ... } { Scotch Pound ... }	6,000 8,000 5,760 7,680	5,825 7,500 5,400 7,200	1,800 Gudean. $\frac{1}{2}$ Babylonian ,,
— —	7,500 7,500	— 7,200	Gudean or Olympic pound 16 ounces Troy ...	— 7,200	7,500 6,750	Gudean. Euboic.
— 6,000	6,750 6,750	6,480 —	Attic pound ... The Hon ...	— —	6,480 6,750	Attic. Euboic.
—	—	—	Found at Naukratis ...	9,600	9,000	Euboic.

TABLE III.

Weights found at Jerusalem.

To show how they have developed from ancient pounds  
(*P.E.F.Q.S.*, 1870, p. 330).

I.	G.T. II.	G.T. III.	G.T. IV.	16 : 15		A.G. VII.	Kats. VIII.	Drams 40 O.G.T. IX.	X.
				O.G.T. V.	O.G.T. VI.				
				*	7,253 5,698 5,674 2,891				
*	3,049 2,321 1,234.5	+ 19 - 105 + 22.5	3,030 2,424 1,212	3,000 2,400 1,200	2,512.5 2,250 1,125	2,500 2,000 1,000	— — —	— — —	

\* Hebrew Inscriptions.

## (8)—THE JERUSALEM WEIGHTS.

We are now in a position to consider the bearing the Jerusalem weights have on the subject.

Of the several weights found in the excavations there are six which may be considered in perfect order and nearly up to full weight. These when tested by me (see p. 336, *Quarterly Statement*, 1870) appear to fall into two series of three weights each, the series having a ratio to each other of 12 : 5, and the three in each scale having the ratio to each other of 5, 4, 2. It may be purely accidental these two series having the same ratio, but we take them as we find them (see Table III).

I give the actual weights in column II and the several corrections (in III) I have made to bring the weights to what I believe to be the correct standard (in IV). The correction to each is very small, in four cases it is not 0·5 per cent., in one case 2 per cent., and in the extreme case 5 per cent.

In column V I apply the correction of 1 per cent. to all the weights to bring them to old grains Troy, and we now find the weights in the following order: 7,200 O.G.T., the commercial raised pound, 16 oz. of the Troy pound, 5,760 O.G.T. the Troy pound, and 2,880 O.G.T. half the Troy pound. So here we have, for certain, weights of the Troy pound with Hebrew inscriptions.

In the second series we have weights of 3,000, 2,400 and 1,200 O.G.T.,  $\frac{5}{12}$  of the first series.

In column VI I show all these weights lowered by  $\frac{1}{16}$ , and in the first series we have the Hon of 6,750, the Tower pound of 5,400 O.G.T., and half the Tower pound.

In the second series we have weights of 2,812·5, 2,250, and 1,125 O.G.T., from which it is clear that they were not used in this condition as grains Troy.

I now, in column VII, turn all the weights from Troy grains to ancient grains by multiplying by  $\frac{8}{9}$ . The first series are, of course, the well-known old pounds and parts in ancient forms.

The transformation of the second series is most interesting; we have now weights of 2,500, 2,000 and 1,000 grains ancient. So it is evident that this was their original condition before they were raised.

We may gather then from these weights that there were in use in early days weights of 2,500, 2,000, and 1,000 A.G., and at some time the grain ancient was changed to grain Troy, *and at the same*

time the pounds were raised in weight  $\frac{1}{15}$  of their weight, and that at this time the Tower pound became the Troy pound, and the Hon became the 7,200 O.G.T. (commercial pound of Central Europe). We further have the certainty that the change took place before the destruction of Jerusalem, and in a time when Hebrew characters were in use.

I think there can be no doubt of the correctness of the process to which I have subjected these weights, when I arrive at such numbers as 6,000, 4,800, 2,400, 2,500, 2,000, 1,000, and that now we are in a position to examine carefully all the weights which have not yet been fully diagnosed, we may be enabled to obtain further interesting information as to the use of the Troy pound in early days. I have no doubt that many of the weights found, in recent years, at Jerusalem, Tel Zakariya, el-Judeideh and Gezer, will be found to belong to a system of which the unit is 180 G.T. *i.e.*,  $\frac{1}{5}$  of 10 Egyptian Kats or 1,440 G.T. (3 oz. Troy).

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#### THE LATE JOHN DICKSON, Esq., M.A., F.R.G.S.

THE *Palestine Exploration Fund* has much cause to regret the death, on July 4th, of Mr. John Dickson, for many years H.B.M. Consul in Jerusalem. He always took a keen interest in the work of the Fund, and was ever ready with sound advice and help in his official capacity, and with warm sympathy and hospitality for those who were engaged on the excavations, which indeed he frequently visited. Born in 1846, he passed through Edinburgh University and entered the Consular Service in 1875, and was first appointed to Mosul, in Turkish Arabia. While on his way there he received orders to remain at Beirut, to fill the post of Vice-Consul, and there he remained for eight years. From there he went as Consul to Damascus, and was in 1890 appointed to Jerusalem where he took up his duties as Consul in that year. Mr. Dickson's health had been failing for the last two or three years, but except during serious illness, he never relaxed in his attention to duty nor in his kindness to the representatives of the Fund. Mr. Dickson leaves a widow, one son, and three daughters, one of whom has from time to time contributed articles of much interest to these pages.

His loss will be deeply felt by all British residents in Jerusalem.

J. D. C.