DANIËL A. WAS

HT 123, A TAX ACCOUNT

I. The text

The text of this tablet from Hagia Triada, written in Linear A, may now[1] be transliterated as follows:

HT 123 face a

(i)	*ki.ta.i*,	olives 31,	oil		$8\frac{1}{2}$,	*ki.ro*	$2\frac{1}{4}$,
(ii)	*pu.82*,	olives $31\frac{1}{4}$,	oil		$8\frac{1}{2}$,	*ki.ro*	$(2\frac{1}{4}+)$,
(iii)	*sa.ru*,	olives 16,	oil		$4\frac{1}{12}$,	*ki.ro*	$\frac{3}{4}$,
(iv)	*da.tu*,	olives 15,	oil		$4\frac{1}{2}$,	*ki.ro*	$\frac{3}{4}$,
(v)	*ku.ro*,	olives $93\frac{1}{4}$,	oil	*ku.ro*	$25\frac{7}{12}$,	*ki.ro*	6+

Legenda:

1. In the transliteration of the first term of entry (i), I have followed Peruzzi[2] in the distinction made between the signs representing respectively the sound values *i* and *no*, both L100; cf. also Pope and Raison[3].
2. The oil species is represented by the sign L90[4], not by the 'normal' olive-oil ideogram L89. L90 is never ligatured, but L89 is nearly always found in ligature with a variety of other signs. It seems possible that these ligatures indicate various spicings, as in Linear B, whereas L90 would signify unadulterated oil, expressed as will be seen at the rate of 20% by weight of olives.

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[1] Cf. W. C. Brice, Inscriptions in the Minoan Linear Script of Class A, 1961 (ILA), J. Raison and M. Pope, Index du linéaire A (Index I), Index transnumeré du linéaire A (Index II), 1971/77, L. Godart and J.-P. Olivier, Recueil des inscriptions en linéaire A, Vol. I, 1976 (GORILA). Fractions as established by the author, Kadmos 10, 1971, 35–51.

[2] E. Peruzzi, Le iscrizioni minoiche, 1960, Atti dell'Acad. Tosc. 24, 1959–60, 31–128.

[3] Kadmos 16, 1977, 16–23; cf. also Index II.

[4] Cf. the author, Kadmos 13, 1975, 95–116.

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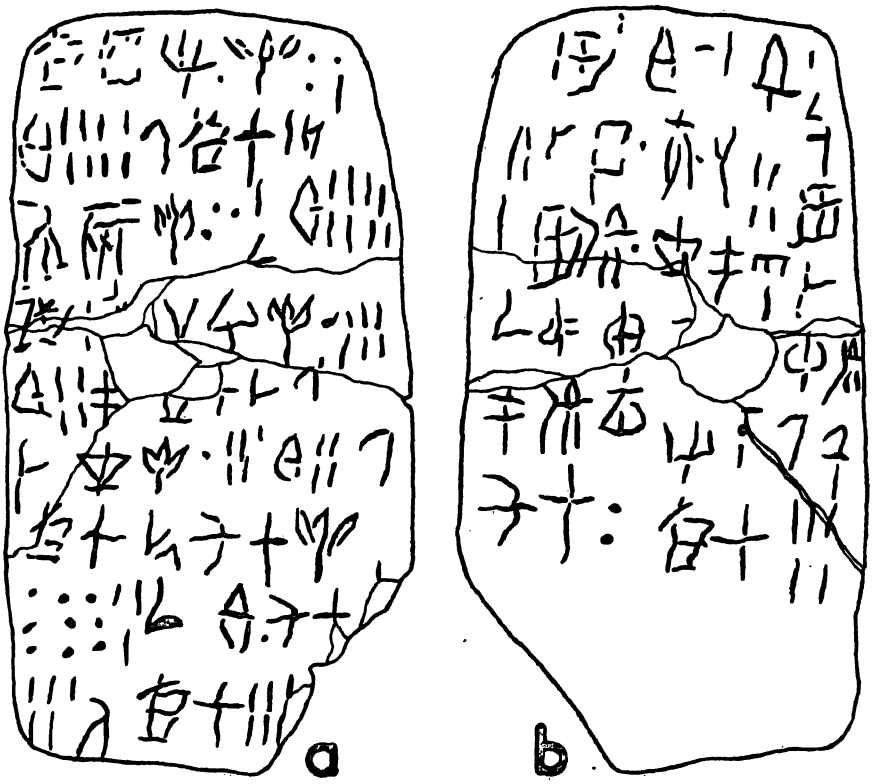
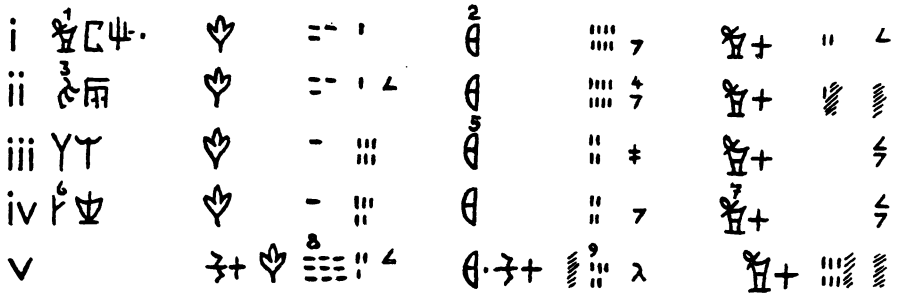


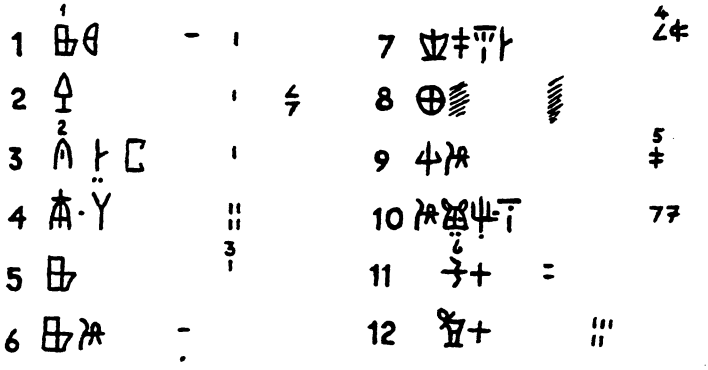
N.B. The Author reads the fraction sign '½' at the end of line b3 rather than at the beginning of line b4—Ed.

3. The fraction at the end of entry (i) has been accepted as representing $\frac{1}{4}$ as in ILA and in Index I. GORILA and Index II suggest 1/24 but it will be shown that such a figure is impossible mathematically and that the reading by Brice should prevail. In that case it becomes imperative to read, with Brice, $2\frac{1}{4}$ not $1\frac{1}{24}$.
4. As to the numbers at the and of entry (ii), here placed between brackets, ILA gives 1+ and GORILA hesitates between $\frac{1}{24}$ and $1\frac{1}{12}$; however it seems fairer to say that these cannot be read with any certainty. The total registered at the end of entry (v), which is six at least, discloses that the unreadable numbers should be as in our text above.

123 a



123 b



N.B. The Author reads the missing second sign in item b8 as a doubtful L26 (*na*)—Ed.

5. Usually the fraction after the oil in entry (ii) is read as $\frac{3}{4}$, which is wrong as it would involve a reversal of the standard position of the two signs – Lm9 and Lm1 (in Index II referred to as J and E) which stand for $\frac{1}{4}$ and $\frac{1}{2}$, whose combination, Lm8 (Index II : JE), makes the sign for $\frac{3}{4}$. It is to be observed that the standard form is found at the end of entries (iii) and (iv). The palimpsest trace of a sign at the beginning of line 4 of the tablet has been mistakenly taken as Lm9. The value of $8\frac{1}{2}$ is required by the total – *ku.ro* – in entry (v).

HT 123 face b

(1) *o* oil	11	(7) *tu.pa.di.da*	$\frac{1}{4} + \frac{1}{30}$
(2) *L36*	$1\frac{3}{4}$	(8) *ka.ṇa* [	$\frac{1}{120}$]
(3) *ti.ḍa.ta*	1	(9) *ne.du*	$\frac{1}{12}$
(4) *pi.sa*	4	(10) *du.ṃa.i.na*	$\frac{7}{8}$
(5) *o*	1	(11) *ku.ro*	20
(6) *o.du*	10	(12) *ki.ro*	5

6. The sign here represented as *o* is L87, not always considered for this vocal, but cf. the author, Kadmos 12, 1973, 134–48, § IV.
7. L36 in entry (2) is untransliterated; The Indexes suggest L23, but cf. GORILA.
8. Entries (9) and (10) have been read as one single term in Index I :] *ne.du.pa.du.pi.za*, (the sign for $\frac{1}{12}$ and for *pa* being the same), but Index II has followed GORILA as represented here.
9. In entry (3), GORILA reads the small dash after the word as a punctuation mark and overlooks the longer and clearer dash under the last syllabic sign; the first is likely palimpsest.
10. Obviously, the total registered does not accord with the total of the preceding numbers. This may be due to one of the following causes.: a) a mistake by the scribe, b) the figure of 10 in entry (6) being a punctuation mark[5], c) the total of 20 referring to the sum of the two largest amounts, entries (1) and (6) minus the one unit of entry (3) written underneath the word – cf. Legend No. 9 – and d) the total of 20 referring to the sum of all items but item (6)[6].

II. *ki-ro*

The text of face a deals with amounts of olives, measured in medimnoi,[7] and with a species of oil, L90, measured in metretes.[8] The only commodity dealt with on face b is that same kind of oil. The puzzle

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[5] Cf. the author, Kadmos 10, op. cit. note 10.

[6] That last entry has the term *o.du*, also found on the cretule ILA Cr V1a and Cr V2b (Index: HT W223 and W222a), but these texts do not throw light upon the meaning of that term.

[7] Of 120 khoinikes and a capacity of 108 litres, cf. the author Kadmos 11, 1972, 1–21.

[8] Of 6 dikhowes, 120 kotylai, 720 kyathoi and a capacity of 32.4 litres = $\frac{3}{10}$ of a medimnos, cf. the author, Kadmos 12, 1973, 28–59.

starts with the last of the successive entries of face a: *ki.ro* followed by numbers. The second row of numbers presents figures which are almost, but not quite, one-quarter of those of the first row, but the figures after the notation *ki.ro* cannot easily be correlated with the preceding figures. In other texts[9] the term *ki.ro* indicates a class of people who were dependent upon the palace administration[10] and frequently employed as supervisors of labourers.[11] In the *ki.ro* list of HT 94a, as in entry (iii), we find an individual of the name *sa.ru*, which implies that *sa-ru* and all the other three corresponding entries on HT 123a, *ki.ta-i*, *pu.82*, and *da-tu*, are personal names.[12] The question arises whether in this text the term *ki.ro* could also be the name of a person: but this is not possible, for no commodity is mentioned after *ki.ro*, and people cannot be counted by fractions. Peruzzi[13] has translated the term as 'deficit', but there is no evident reason why there should have been a deficit in this account; moreover, there is no indication as to whether such a deficit refers to the olives or to the L90 species of oil; in short such an interpretation of the text would pose excessive problems.

I long hesitated to tackle this term *ki.ro* until I became convinced that, despite the complications[14], Peruzzi must be followed in connecting it with the Indo-European root 2. *(s)kel-*, 'to be indebted'. My argument runs that a Minoan neuter *s*-stem *(s)kilos* is required to explain the connected terms *ki.re.ta*$_2$ and *ki.re.ta.na*,[15] and that this term corresponds semantically to the Greek τέλος. It seems quite possible that there could be a plural masculine *(s)kiloi*, denoting the 'debtors' to the palace administration, and a corresponding neuter form meaning 'due', 'duty', or 'debt': both would have to be written identically in Linear A. The term on HT 123 would then have the latter meaning. The next step is to find a correlation between the various numbers listed in the text.

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[9] HT 1, 15, 30, 34, 88, 94, 117.

[10] Cf. the author, Minos 16, 1977, 7–11.

[11] Cf. the author, Kadmos 11, op. cit.

[12] Consequently, L82 was used as a phonogram as well as to denote the commodity wine; possibly = *tu*$_2$, cf. the Cypriot classical syllabary.

[13] Op. cit. 118.

[14] The root in question is only attested in Germanic and in Balto-Slavonic, cf. J. Pokorny, Indogerm. Wb. I, 927.

[15] Cf. the author, Kadmos 17, 1978, 91–101.

III. The dues on olives and on oil

We start from the assumption that the text is a tax account, and note that face b deals exclusively with oil. It follows that the amounts of olives recorded on face a were either left untaxed – which is unlikely, for if that had been the case there would have been no point in recording that commodity – or, alternatively, that the entire tax was levied in the form of oil. If we accept for the moment this second alternative, we can derive a formula from entries (iii) and (iv) which record the same amount after *ki.ro.* but slightly different amounts of olives and of oil.[16] The equation to be extracted from entries (iii) and (iv) is:

$$16x + 4\tfrac{1}{12}y = 15x + 4\tfrac{1}{2}y$$

in which x represents the amount of oil (in metretes) due for a medimnos of olives, and y the amount (again in metretes) due for one metretes of oil. This equation can be reduced to

$$x = \tfrac{5}{12}y$$

This neat result provides confirmation of our working assumption that both products were taxed.

With regard to this ratio of $\frac{5}{12}$, the following observation may be made. A medimnos of olives weighs between 60 and 65 kilograms, say, 62.5 kilograms on average. Under modern conditions ripe olives yield between 20% and 30% by weight of oil, and the lower of these two percentages would doubtless be that more in accordance with the output through the primitive pressing techniques of Minoan times. 62.5 kilograms of olives, at a yield of 20%, would therefore produce 12.5 kilograms of oil. Now one metretes of oil, of 32.4 litres volume and 0.92 kilograms per litre specific gravity, has a weight of 29.8 kilograms. $\frac{5}{12}$ of this weight is 12.41 kilograms, which corresponds neatly with the figures of 12.5 kilograms just calculated as the yield from the weight of olives which was anciently reckoned as equivalent for tax purposes.[17]

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[16] It is an advantage that the quantities of the taxed commodities in the two entries are so close, for this makes it less likely that some complicating factor such as taxation on a sliding scale may be leading us astray.

[17] The figure of $\frac{5}{12}$ metretes for the yield of oil from one medimnos of olives (or at least the theoretical yield accepted for the purposes of taxation) fits nicely into the system of measurement, corresponding as it does to five khowes.

IV. The assessment of tax

The level of taxation may be deduced from face a of the tablet. At the outset reference should be made to the complication mentioned above as Legend No. 3. If we are correct in following Brice's reading of $2\frac{1}{4}$ at the end of entry (i) it follows from face a that the tax was progressive; for the duty recorded in entry (i) is three times that in entry (iv), although the associated amounts of olives and oil are only about double. Such a progression may result from one of two systems: 1) the application of a progressive rate or 2) the acceptance of a tax-free base. Either or both of these possibilities may be involved. However, since in the case of some entries on face b minute quantities of oil are recorded, it seems highly unlikely that the second possibility (that of a tax-free base) applied in the case of the impost on oil. We look therefore to the first possibility and endeavour to deduce the progressive rate of tax which applied to the oil.

Now we can infer from entry (iv) of face a the minimum as well as the maximum possible rates of taxation on the oil, as follows. If we assume that the olives, as distinct from the oil, were fully taxed at a flat rate, entry (iv) could by resolved into the equation:

$$15\ (\tfrac{5}{12}y) + 4\tfrac{1}{2}y = \tfrac{3}{4}$$

(y signifying, as above, the rate of tax on the oil, and the rate for olives being $\frac{5}{12}y$ as already established). This equation can be resolved to $y = \frac{3}{43}$, an impossible fraction in the Minoan system. The assumption that olives were subject to a full flat tax must therefore be wrong; but it serves to establish the lowest possible rate of tax for the oil ($\frac{3}{43}$) if the olives were fully taxed. At the other extreme, on the assumption that there was no tax on the olives and that it were to fall completely on the oil, the equation would read:

$$4\tfrac{1}{2}y = \tfrac{3}{4}$$

and therefore $y = \frac{1}{6}$. The highest possible rate of tax on the oil would, in other words, be $\frac{1}{6}$ for the amount here considered.

Now between these extreme limits of $\frac{3}{43}$ and $\frac{1}{6}$, the only possible fractions from the HT system of measurement that could have applied are $\frac{2}{15}$, $\frac{1}{8}$, $\frac{1}{9}$, $\frac{1}{10}$ and $\frac{1}{12}$. Before attempting to decide which of these was employed, it may be convenient to list them along with their equivalents in other units of measure:

1 metretes	$\frac{2}{15}$	$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{10}$	$\frac{1}{12}$
= 12 khowes		$1\frac{1}{2}$	$1\frac{1}{3}$		
= 120 kotylai	16	15	$13\frac{1}{3}$	12	10
= 720 kyathoi			80		

In order to decide which of these columns corresponds with the Minoan system, we must call in the help of face b of our tablet. It will be recalled that this lists ten separate amounts of oil, each along with a personal name, a total of 20 (though there is reason to think this may have been an error for 30), and an amount of 5 due as tax.

If, as a working hypothesis, we take from face a item (iv) the figure of $4\frac{1}{2}$ metretes of oil as the upper limit of the low-tax bracket, we can distinguish between eight of the ten itemized entries on face b that are below this figure, and the remaining two (Nos. (1) and (6)) that are above it. In these latter two cases, the recorded amounts would presumably be divided, when assessed for purposes of taxation, between two or more brackets. Thus the amount of 11 metretes of entry (1) would be considered as $4\frac{1}{2}$ and $5\frac{1}{2}$. If we take the alternative possible totals of 20 and 30, the statistics may be summarized in the following table:

	Possible total	20		30	
1.	in the lower tax-bracket:				
a)	total of amounts less than $4\frac{1}{2}$ metretes	9 .	$13\frac{1}{2}$	9	18
b)	first $4\frac{1}{2}$ metretes of two larger entries	$4\frac{1}{2}$		9	
2.	in the higher tax-brackets (i.e. excess over $4\frac{1}{2}$ metretes in the two larger entries)	$6\frac{1}{2}$		12	

By calculation it can be shown that there is only one simple solution[18] which fits with the two possible totals. This involves a levy of $\frac{1}{9}$ on the first $4\frac{1}{2}$ metretes, of $\frac{2}{9}$ on the second $4\frac{1}{2}$ metretes, of $\frac{3}{9}$ on the third $4\frac{1}{2}$, and so forth. It follows of course that the full tax within successive brackets would be $\frac{1}{2}$, 1, $1\frac{1}{2}$ metretes, and so on in like progression. When these figures are applied to the preceding table, the following results ensue:

[18] As no certainty exists that the first tax bracket does not exceed $4\frac{1}{2}$, other higher values have been tried but without giving an acceptable result; also much higher values increase out of proportion the tax due on the olives.

Possible total	20	30
At $\frac{1}{9}$	$13\frac{1}{2} = 1\frac{1}{2}$	$18 = 2$
At $\frac{2}{9}$	$4\frac{1}{2} = 1$	$9 = 2$
At $\frac{3}{9}$	$2 = \frac{2}{3}$	$3 = 1$
Total tax-yield, in metretes	$3\frac{1}{6}$	5

Only the right-hand column produces a tax total corresponding with that recorded on face b of the table (under *ki-ro*), and we must therefore suppose that the scribe made a mistake in writing the total (after *ku-ro*) as only 20 instead of 30. Of the other possibilities envisaged under Legend No 10, b) is ruled out by the above reckoning, while c) and d) would result in a flat rate of $\frac{1}{4}$ which would not accord with the progression needed to explain face a.

In entry (iv) of face a the total tax recorded is $\frac{3}{4}$ metretes. Of this, $\frac{1}{2}$ metretes came from the levy ($\frac{1}{9}$) on the $4\frac{1}{2}$ metretes of oil, and this leaves $\frac{1}{4}$ metretes to come from the 15 medimnoi of olives. We have already deduced (above, p. 98) that the rate of taxation on a medimnos of olives was $\frac{5}{12}$ of the amount of oil due on a metretes of oil, which we have just established as $\frac{1}{9}$. The levy on olives was therefore $\frac{5}{12} \times \frac{1}{9} = \frac{5}{108}$. It follows that in order to yield the $\frac{1}{4}$ metretes due from the 15 medimnoi of olives recorded in entry (iv), only 5.4 medimnoi were taxed

$$(5.4 \times \tfrac{5}{108} = \tfrac{1}{4}),$$

the remaining 9.6 medimnoi being exempt from tax.

The significance of this tax-free weight of 9.6 medimnoi of olives may become clearer if we note first that 9.6 is two-fifths of 24, and then turn to the only equation as yet not fully considered – that to be derived from entry (i) of face a.[19] It can be expressed as follows:

$$\tfrac{5}{108}(31-Z) + (\tfrac{1}{9} \times 4\tfrac{1}{2}) + (\tfrac{2}{9} \times 4) = 2\tfrac{1}{4}$$

in which Z is the tax-exempt amount of olives. The solution is

$$Z = 12.4 \text{ (medimnoi)}$$

which is exactly two-fifths of the listed amount of 31 medimnoi.

It is to be remarked that this same equation may be expressed as follows:

$$(\tfrac{1}{36} \times 31) + (\tfrac{1}{9} \times 4\tfrac{1}{2}) + (\tfrac{2}{9} \times 4) = 2\tfrac{1}{4}$$

[19] The oil taxed at $\frac{1}{9}$ for the first $4\frac{1}{2}$ and $\frac{2}{9}$ for the remaining 4 metretes.

which involves a rate of taxation of $\frac{1}{36}$ metretes of oil for each medimnos of olives. Further, $\frac{3}{5}$ (the taxable ratio of olives of an amount of 24 medimnoi or less) × $\frac{5}{108}$ (the relevant tax-rate) = $\frac{1}{36}$. It follows that the rate was evidently $\frac{1}{36}$ in all such cases, but that, if the amount of olives was less than 24 medimnoi, only that weight which exceeded 9.6 medimnoi ($\frac{2}{5} \times 24$) was liable for tax at the rate of $\frac{5}{108}$.

We may now revert briefly to the question raised in Legend 3 (above, p. 94) of the possible reading of $1\frac{1}{24}$ at the end of face a entry (i), as suggested in GORILA and Index II. If we apply to that entry the conclusions deduced from face b only, the recorded amount of oil, $8\frac{1}{2}$ metretes, may be reckoned to have been taxed at the rate of

$$(\tfrac{1}{9} \times 4\tfrac{1}{2}) + (\tfrac{2}{9} \times 4) = \tfrac{25}{18}.$$

This fraction is higher than the suggested $1\frac{1}{24}$, and must therefore be rejected, as proposed in Legend 3.[20]

In the light of the tax-free allowance on olives and the progessive nature of the impost on oil, it is manifest that the levy on oil was appreciably more onerous than that on olives. The administration seems then to have discouraged the production of oil by individuals, perhaps because this oil was considered competitive with its own. Olives, on the other hand, apart from those consumed by the growers, would have been sold to the HT administration for pressing.[21]

An amusing corollary of this interpretation of face a is that the tax-paying inhabitants of Hafia Triada seem to have been as aware as we of the need to avoid overlapping into the next higher tax bracket.

V. Summary

HT 123 appears to be a record of the tax paid by a number of individuals on the production of both olives and oil, though paid in oil only. Up to the level of 24 medimnoi of olives, only that amount which

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[20] Incidentally, it seems evident that the choice was between $2\frac{1}{4}$ and $2\frac{1}{12}$, not $1\frac{1}{24}$, the named authors having been led astray by the palimpsest traces on the tablet.

[21] The texts show that olives were sometimes used to make up the pay to the labourers, cf. the author, Minos 14, 1973, 7–16.

exceeded the tax-free allowance of 9.6 medimnoi ($\frac{2}{5}$ of 24) was liable for tax at the rate of $\frac{5}{108}$ metretes of oil for each medimnos of olives. If the total exceeded that level the rate was $\frac{1}{36}$. The oil produced by these farmers was taxed progressively at $\frac{1}{9}$, $\frac{2}{9}$, $\frac{3}{9}$, etc., for each successive holding of $4\frac{1}{2}$ metretes of oil: thus at the top of each bracket the tax was $\frac{1}{2}$, 1, $1\frac{1}{2}$ metretes, and so forth.