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HOW DID EGYPTIAN SCRIBES CALCULATE NET DRACHMAE IN WEST BANK
TAX RECEIPTS?

aus: Zeitschrift für Papyrologie und Epigraphik 76 (1989) 63–68

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How Did Egyptian Scribes calculate Net Drachmae in West Bank Tax Receipts?*

Many tax receipts from the West bank of the Nile opposite Thebes (cf. for these above pp. 45ff.) have payments recorded as follows:

(δρ.) δ αἰ κ(αθαραῖ) (δρ.) γ (τετρώβολον) (ἡμιωβέλιον),

i.e. an amount of drachmae is followed by an amount smaller by a supplementary fee of 1/16th, reckoned on the basis of a 6 obol drachma. For such gross/net drachmae cf. the now classic monograph by A. Gara, *Prosdigraphomena e circolazione monetaria*, Milano 1976.

What concerns us here is the question, how the Egyptian scribes calculated the difference between the the higher and the lower amounts. As a working hypothesis it may be assumed that their point of departure was an official ruling to the effect that the supplementary fee to be deducted from a single tetradrachm (= 4 x 6 obols at 8 chalci each) was 1/16th (or 6.25%; but the Egyptians did not reckon with percentages as we do): 4 dr. (= 192 ch.) - 1/16th = 180 ch. = 3 dr., 4 ob., 4 ch. (= 3 dr., 4 $\frac{1}{2}$ ob.). As it is common knowledge that the Egyptians were used to calculations based upon multiplication or division by 2, one can draw up a table:

	if 4 dr. gross	→	3 dr., 4 ob., 4 ch. net,
then :: 2,	2 dr. gross	→	1 dr., 5 ob., 2 ch. net,
:: 2,	1 dr. gross	→	5 ob., 5 ch. net.
As 1 dr. = 6 ob.,			
:: 2,	3 ob. gross	→	2 ob., 6 $\frac{1}{2}$ ch. net.

It is no great problem, then, to calculate the net value of 1 ob. (= 8 ch.) gross:

	8 ch. (= 1 ob.) gross	=	7 $\frac{1}{2}$ ch. net
:: 2,	4 ch. (= $\frac{1}{2}$ ob.) gross	=	3 $\frac{3}{4}$ ch. net
:: 2,	2 ch. (= $\frac{1}{4}$ ob.) gross	=	1 $\frac{7}{8}$ ch. net

[The Egyptian scribes would have written $\frac{7}{8}$ as $\frac{1}{2} \frac{1}{4} \frac{1}{8}$.]

With the help of the calculations made above one can draw up a more complete table which shows gross amounts converted into net amounts:

* It is my pleasure to thank Prof. J. Schwartz (Strasbourg), Dr. G. Poethke (Berlin) and Dr. R.A. Coles (Oxford) for their kind help in verifying a number of readings in texts published in O.Stras., O.Theb., O.Tait II and WO II. Prof. R.S. Bagnall was so kind as to correct my English and to suggest a few improvements in order to make the presentation more clear. Furthermore I should like to put on record my gratitude towards my colleague W. Liesker with whom I had the pleasure of discussing several aspects of my investigation. Of course, the responsibility for the conclusion of this article is mine.

2 ch.	=	$\frac{1}{4}$ ob.	=	$1\frac{7}{8}$ ch.
4 ch.	=	$\frac{1}{2}$ ob.	=	$3\frac{3}{4}$ ch.
6 ch.	=	$\frac{3}{4}$ ob.	=	$5\frac{5}{8}$ ch.
8 ch.	=	1 ob.	=	$7\frac{1}{2}$ ch.
2 ob.	=	1 ob.,	7 ch.	
3 ob.	=	2 ob.,	$6\frac{1}{2}$ ch.	
4 ob.	=	3 ob.,	6 ch.	
5 ob.	=	4 ob.,	$5\frac{1}{2}$ ch.	
6 ob. = 1 dr.	=	5 ob.,	5 ch.	
2 dr.	=	1 dr.,	5 ob.,	2 ch.
3 dr. (= 1 + 2 dr.)	=	2 dr.,	4 ob.,	7 ch.
4 dr. (= 2 x 2 dr.)	=	3 dr.,	4 ob.,	4 ch.
5 dr. (= 2 + 3 dr.)	=	4 dr.,	4 ob.,	1 ch.
6 dr. (= 2 x 3 dr.)	=	5 dr.,	3 ob.,	6 ch.
7 dr. (= 3 + 4 dr.)	=	6 dr.,	3 ob.,	3 ch.
8 dr. (= 3 x 4 dr.)	=	7 dr.,	3 ob.	

As the texts rarely indicate amounts higher than 8 dr., one can break off the table here; the calculation of higher amounts is in itself easy enough by way of adding up or multiplying smaller amounts.

In practice the smallest coin apparently had a value of 2 chalci (cf. L. C. West - A. C. Johnson, *Currency in Roman and Byzantine Egypt*, chapt. V); amounts less than 2 chalci were left out of account, i.e. the scribe rounded off, sometimes upward, sometimes into the opposite direction.

Our next step will be to compare these 'theoretical values' with the data actually found in the texts themselves. One encounters the following conversions from gross drachmae into net drachmae (NB: if different texts show different conversion values, the best approximation is printed with bold face and underlined>. Omitted from this table are, of course, texts in which one of the sums has been supplied in restoration by a modern editor.):

Gross			Net			Theoretical Net			Reference
dr.	ob.	ch.	dr.	ob.	ch.	dr.	ob.	ch.	
		2	=		1				O.Theb. 35
	2		=	1.5	2	1.5	3		O.Cambr. 44
	4	2	=	4		3	<u>7.875</u>		O.Tait 521
	5		=	4.5		4.5	1.5		O.Petr. 84
1			=	5.5		5.5	1		O.Theb. 40; O.Tait II 878; O. Cambr. 37
1	.5		=	1		1	.75		O.Meyer 44
1	2		=	1	1.5	1	1.5		O.Petr. 88
1	2.5		=	1	2	1	1	<u>7.75</u>	O.Cair.GPW 50
1	3		=	1	2	1	2	3.5	WO II 1418

Gross				Net			Theoretical Net			Reference
dr.	ob.	ch.	=	dr.	ob.	ch.	dr.	ob.	ch.	
1	5		=	1	4		1	4	2.5	O.Petr. 84
			=	1	4	2	1	4	2.5	O.ROM II 126 ^a
			=	1	4.5		1	4	2.5	O.ROM I 18.9
1	5.5		=	1	5		1	4	6.25	O.Tait II 554
2			=	1	5		1	5	2	BIFAO 87 (1987) 202
			=	1	5	2	1	5	2	O.Tait II 537
			=	1	5.5		1	5	2	O.Cair.GPW 58 ^b
2	.5	2	=	2			1	5	7.625	O.Stras. 277; O.Tait II 1036; 1042; O.ROM II 102; 103; O.Theb. 37
2	1		=	2			2		1.5	O.Theb. 33; O.Petr. 84
2	1.5		=	2	.5		2	.5	1.25	O.Cair.GPW 48; O.ROM I 17.8 + BL VII 292; SB V 8047 + BIFAO 87 (1987) 203
2	2		=	2	1		2	1	1	O.Tait II 875; O.ROM II 18.5 + BL VII 292; O.Cambr. 33
2	2.5		=	2	1.5	2	2	1.5	.75	WO II 461; 463
2	3		=	2	1.5	2	2	2	.5	O.Tait II 510; O.Cair.GPW 98; WO II 448; 452; 465; O.ROM I 16; O.Stras. 85 ^c
			=	2	2		2	2	.5	WO II 438; 444; O.Tait II 882
			=	2	2	2	2	2	.5	O. Cambr. 45 ^c
2	3	2	=	2	2		2	2	2.375	O.Aberd. 77 ^d

^a The photo of O.ROM II 126 shows that the transcript is correct. Evidently the scribe omitted (as happens more often) to indicate the number of chalci involved; parallel texts show that one must reckon with 2 chalci rather than the editor's 1 chalcus; cf. for this below, note c, ad O.ROM I 16.

^b According to the editors of the ostrakon the scribe calculated 2 chalci = $\frac{1}{4}$ ob. in excess.

^c Tait suggested (cf. BL II.1 27) a reading of the net amount in O.Stras. 85 as 2 dr., $2\frac{1}{2}$ ob., 2 ch.; this was in opposition to the text read in the ed.princ., .. — (ἡμιωβέλιον) χβ, i.e. 1 obol less. In fact, this latter reading works out more satisfactorily, as $\frac{15}{16}$ of 2 dr., 3 ob. has been calculated in a number of texts as 2 dr., $1\frac{3}{4}$ ob. As I felt that one should probably combine the reading of the ed.princ. with Tait's suggested more complete reading I asked Prof. Schwartz to check the original ostrakon. He kindly sent me (by letter from 11.viii.1988) a drawing of the passage under review which makes me believe that the net amount can be read indeed as αἰ (καθαραὶ) β — (ἡμιωβέλιον) χβ. The theoretical result of a conversion of 2 dr., 3 ob. gross = 2 dr., 2 ob., $\frac{1}{2}$ ch. net, i.e. a difference of $2\frac{1}{2}$ ch. with the amount actually indicated here (2 dr., $1\frac{1}{2}$ ob., 2 ch.); obviously, the scribe in O.Cambr. 45 rounded off upwardly (he gives for the same gross amount a net conversion value of 2 dr., 2 ob., 2 ch.). BL VII records a correction for O.Rom. I 16 according to which an amount of 2 dr., 3 ob. gross was converted into 2 dr., 0.5 ob., 1 ch. net. A check of the plate of the ostrakon itself convinces me that the correction needs further correction: I read the net amount as 2 dr., 1.5 ob., 2 ch. (for the amount of chalci cf. above, note a).

^d The editor of the text remarks that the deduction of the text is abnormally high, i.e. $2\frac{1}{4}$ ob. on a total of 2 dr., $4\frac{1}{4}$ ob. A check of the plate convinces me that one can read the amount of gross drachmae as 2 dr., 3 ob., 2 ch. and this eliminates the difficulty of an abnormally high deduced amount. Even so, however, the text does not quite conform to normal practice in that one would expect the theoretical conversion value of 2 dr., 3 ob., 2 ch. to be: (1 dr., 5 ob., 2 ch.) + (2 ob., $6\frac{1}{2}$ ch.) + ($1\frac{7}{8}$ ch.) = 2 dr., 2 ob., $2\frac{3}{8}$ ch. The actually

Gross				Net				Theoretical Net			Reference
dr.	ob.	ch.	=	dr.	ob.	ch.		dr.	ob.	ch.	
2	4		=	2	3			2	3		O.Petr. 84
2	5.5	2	=	2	4	2		2	4	5.125	O.Theb. 34 ^e
3	.5		=	2	5.5			2	5	2.75	O.Meyer 22; WO 419; 429; ^f 431
3	.5	2	=	2	5	2		2	5	4.625	O.Tait II 885 ^g
3	1		=	2	5.5			2	5.5	2.5	WO II 422; 423; 434; 437; O.Petr. 83; O.Theb. 32
			=	2	5.5	2		2	5.5	2.5	O.Tait II 898
3	2		=	3	1			3		6	O.Heid. 257; O.Stras. 281 ^h
3	2.5	2	=	3	1.5			3	1	3.625	O.Lund 4 + BiOr 39, 574 ⁱ
3	3.5		=	3	2			3	2	1.25	WO II 431
3	4.5		=	3	3			3	3	.75	O.Tait 467
4			=	3	4			3	4	4	O.ROM II 122.3; O.Tait 879.7 ^j
			=	3	4.5			3	4.5		WO II 423 and passim
4	1.5		=	4				3	5	7.25	SB XIV 12006; 12008; O.ROM II 103; O.Tait II 1036; O.Petr. 85
4	2.5		=	4	.5	2		4	.5	2.75	O.Tait II 896
4	3		=	3 (?)	5 (?)			4	1	2.5	O.Stras. 185 ^k

indicated net amount (2 dr., 2 ob.) is seen to show a difference slightly higher than 2 ch. (cf. above).

^e The edition gives the conversion of the gross drachmae into net drachmae as 2 dr., 5 $\frac{1}{2}$ ob., 2 ch. becoming 2 dr., 4 ob., 2 ch. But the application of the table of the theoretical values of the gross amount yields a net result of 2 dr., 4 ob., 5 $\frac{1}{8}$ ch. and this would presumably have been rounded off (upward) to 2 dr., 4 $\frac{1}{2}$ ob., 2 ch. or (downward) to 2 dr., 4 $\frac{1}{2}$ ob. Upon my request to check the original ostrakon (now kept in the Ashmolean Museum), whether this perhaps shows a sign for $\frac{1}{2}$ after the numeral 4 in the indication of the obols in the net amount, Dr. Coles reports that there is some surface damage at the crucial point; he thinks that the sign may have been there.

^f Dr. Poethke informs me by letter (d.d. 9.viii.1988) that in WO II 429.6 ($\delta\rho$) $\gamma c \alpha i \kappa(\alpha\theta\alpha\rho\alpha i)$ ($\delta\rho$) β ($\pi\epsilon\nu\tau\acute{o}\beta\omicron\lambda\omicron\nu$) c should be read (the ed.princ. reads ($\delta\rho$) γ — c) and that the reading in 431.9 is correct.

^g The theoretical net result of the conversion is (2 dr., 4 ob., 7 ch.) + (5 $\frac{5}{8}$ ch.) = 2 dr., 5 ob., 4 $\frac{5}{8}$ ch., i.e. 2 $\frac{5}{8}$ ch. more than the amount actually indicated. Dr. Coles tells me that the editor's reading is correct.

^h The amount given for the net drachmae in the ed.princ. of O.Stras. 281.3 is slightly too low, if compared with the conversion in O.Heid. 257. Prof. Schwartz tells me (by letter from 11.viii.1988) that one can read the net amount as ($\delta\rho$) γ —. Under all circumstances is the theoretical result of a conversion of 3 dr., 2 ob. gross: (2 dr., 4 ob., 7 ch.) + (1 ob., 7 ch.) = 3 dr., 0 ob., 6 ch. net, i.e. 2 ch. less than the amount actually indicated.

ⁱ I think that the first editor wrongly rejected (note to line 7) his alternative reading of 3 dr., 2 $\frac{1}{2}$ ob., 2 chalci in favour of 3 dr., 2 ob., 2 ch. (probably he was influenced by his incorrect reading of the net amount [corrected in BiOr 39 (1982) 574 as 3 dr., 1 $\frac{1}{2}$ ob.; read in BiOr for 'O': (' $\text{H}\mu\iota\omega\beta\acute{\epsilon}\lambda\iota\omicron\nu$)]; in any case, I read the amount of gross drachmae as 3 dr., 2 $\frac{1}{2}$ ob., 2 chalci.

^j The net value of 4 dr. is represented by most of the documents as 3 dr., 4 $\frac{1}{2}$ ob. In only these two texts the amount reads 3 dr. 4 ob.; no doubt the writer left out the symbol for $\frac{1}{2}$ ob. by mistake. (Dr. Coles informs me that there is no reason to think of an editorial mistake in the case of O.Tait II 879.7; the editors of O.ROM II 122 obviously paid extra attention to their reading).

^k The editor has considered a reading of the net sum as 3 (?) dr., 5 ob.; the reading of the symbol for 5

Gross			Net			Theoretical Net			Reference
dr.	ob.	ch.	dr.	ob.	ch.	dr.	ob.	ch.	
4	3.5	2	=	4	2	4	2	.125	WO II 1613
4	4	2	=	4	2.5	4	2	3.875	O.Petr. 99
5			=	4	4	4	4	1	O.Tait II 1950 ^l
6	2	2	=	6		5	5	6.875	O.Theb. 36
6	3		=	6		6		4.5	O.Petr. 89 ^m
7	.5		=	6	4	6	3	6.75	O.Petr. 79; WO II 1379 + BL II.1 106
7	1		=	6	4	6	4	2.5	O.Meyer 25
8			=	7	3				O.Meyer 22; O.ROM II 96; O.Tait II 518; 879; O.Cair. GPW 98; WO II 472
36			=	33	4.5				O.Tait II 874

It is easy enough to compare these actual conversions with the theoretical values (arrived at through a combination of entries out of the first table). From such a comparison it appears that most often the difference between 'theoretical' and 'actual' amounts is less than 2 chalci. To give an example: in WO II 463.9 2 dr., 2 $\frac{1}{2}$ ob. gross are converted into 2 dr., 1 $\frac{1}{2}$ ob., 2 ch. (= 2 dr., 1 ob., 6 ch.) net. The elements constituting the 'theoretical' conversion are (cf. above):

$$\begin{array}{r}
 2 \text{ dr.} = 1 \text{ dr.}, 5 \text{ ob.}, 2 \text{ ch.} \\
 2 \text{ ob.} = 1 \text{ ob.}, 7 \text{ ch.} \\
 \frac{1}{2} \text{ ob.} = 3 \frac{3}{4} \text{ ch.} \\
 \hline
 2 \text{ dr.}, 2 \frac{1}{2} \text{ ob.} = 2 \text{ dr.}, 1 \text{ ob.}, 4 \frac{3}{4} \text{ ch.} = 2 \text{ dr.}, 1 \frac{1}{2} \text{ ob.}, \frac{3}{4} \text{ ch.},
 \end{array}$$

i.e. the difference with the actual conversion is 1 $\frac{1}{4}$ ch. Obviously, the scribe rounded off upwardly.

Another example shows a rounding off into the opposite direction: in WO II 431.8 3 dr., 3 $\frac{1}{2}$ ob. gross are converted into 3 dr., 2 ob. net. The elements constituting the 'theoretical' conversion are:

$$\begin{array}{r}
 3 \text{ dr.} = 2 \text{ dr.}, 4 \text{ ob.}, 7 \text{ ch.} \\
 3 \text{ ob.} = 2 \text{ ob.}, 6 \frac{1}{2} \text{ ch.} \\
 \frac{1}{2} \text{ ob.} = 3 \frac{1}{4} \text{ ch.} \\
 \hline
 3 \text{ dr.}, 3 \frac{1}{2} \text{ ob.} = 3 \text{ dr.}, 2 \text{ ob.}, 1 \frac{1}{4} \text{ ch.}
 \end{array}$$

Obviously, the scribe did not bother about rounding off 1 $\frac{1}{4}$ ch. into 2 ch. but rather neglected this.

obols is, according to him, clear enough, but gamma "was man vorher erwarten könnte, scheint nach meiner Nachzeichnung nicht dazustehen, doch würde es der Zusammenhang eigentlich erfordern". But the editor is mistaken; for the principal amount in the net sum a delta rather than a gamma is expected. I asked Prof. Schwartz to check the original ostrakon in order to see what could be read; he reports (by letter from 11.viii.1988) that after the numeral 4 in the amount of gross drachmae nothing is readable any longer.

^l The editors read the net amount as 4 dr., 3 ob., but this is 1 obol too low, i.e. just the cross-bar projecting to the right out of a 3 obols-symbol. Dr. Coles kindly checked the original ostrakon and confirms my suggestion that one should read 4 dr., 4 ob.

^m The 'theoretical' net amount of 6 dr., 3 ob. gross is (5 dr., 3 ob., 6 ch.)+ (2 ob., 6 $\frac{1}{2}$ ch.) = 6 dr., 0 ob., 4 $\frac{1}{2}$ ch.), i.e. 2 $\frac{1}{2}$ ch. more than what is actually indicated on the ostrakon itself.

It would go, however, too far to say that the difference between theoretical and actual amounts is always less than 2 chalci (the smallest currency unit) and that greater differences are systematically avoided. In O.Petr. 84 one finds a conversion of 1 dr., 5 ob. gross into 1 dr., 4 ob. net. Theoretically one would expect:

$$\begin{array}{r} 1 \text{ dr.} = 5 \text{ ob.}, 5 \text{ ch.} \\ 5 \text{ ob.} = 4 \text{ ob.}, 5 \frac{1}{2} \text{ ch.} \\ \hline 1 \text{ dr., } 5 \text{ ob.} = 1 \text{ dr., } 4 \text{ ob.}, 2 \frac{1}{2} \text{ ch.,} \end{array} +$$

i.e. $2 \frac{1}{2}$ ch. have not been taken into account (on the other hand, the scribe of O.ROM I 18.b exaggerated by converting the same gross amount into 1 dr., $4 \frac{1}{2}$ ob., i.e. he reckoned $1 \frac{1}{2}$ ch. too much.).

In BIFAO 87 (1987) 202 the scribe who converted 2 dr. gross into 1 dr., 5 ob. net obviously neglected 2 chalci; but his colleague in O.Cair.GPW 58 reckoned 2 chalci in excess. Likewise, the scribes who converted an amount of 3 dr., 1 ob. gross into 2 dr., $5 \frac{1}{2}$ ob. net neglected $2 \frac{1}{2}$ chalci:

$$\begin{array}{r} 3 \text{ dr.} = 2 \text{ dr.}, 4 \text{ ob.}, 7 \text{ ch.} \\ 1 \text{ ob.} = 7 \frac{1}{2} \text{ ch.} \\ \hline 3 \text{ dr., } 1 \text{ ob.} = 2 \text{ dr., } 5 \text{ ob.}, 6 \frac{1}{2} \text{ ch.} (= 2 \text{ dr., } 5 \frac{1}{2} \text{ ob., } 2 \frac{1}{2} \text{ ch.}). \end{array} +$$

Cf. also footnotes d, e, f, g, h, l and m for similar cases of differences greater than 2 chalci. But in all these cases the amount in excess is only a fraction of a chalcus and it occurs only rarely that the difference amounts to more than $2 \frac{1}{2}$ ch. (cf. fnn. e, f, j); in some cases one is probably dealing with nothing more than a scribal error.

Our conclusion must be, then, that the scribes, if they ever used a table of conversions of gross amounts into net amounts of money, used it with a rather liberal hand, i.e. they did not always take care to calculate net amounts precisely down to the last 2 chalcus-piece. Often enough this meant in practice that the differences between 'theoretical' and actual conversion values worked out to their own benefit and that these penny-pinchers 'earned' an extra 2 chalcus-piece on top of the normal charges.

Finally, it may be useful to add that most of these conversions are found in tax receipts for only 4 taxes: dyke-tax, naubion, geometria, and the tax on linen-weavers. Each tax is represented by a number of West bank ostraka. For the following taxes we have only 1 single West bank text representing a payment for the tax in question:

tax on olive-oil (?): O. Meyer 43 (for the provenance cf. BL II.1 15; or resolve in line 2 ἐλαίου(υργῶν), i.e. a tax on oil-manufacturers [cf. the other taxes on trades, i.e. the tax on linen-weavers and the tax on cobblers]?);

tax on cobblers: O.Tait II 1042;

tax for the imperial statue: O.Tait II 814.