THE ABACUS AND THE CALENDAR, II[1]

(PLATE 57)

CLOSER consideration of the accounts of the Other Gods in *I.G.*, I², 324 reveals a difference between their bookkeeping methods and those of Athena Polias. The difference presumably originated with the two boards of Tamiai, since the Logistai who audited both accounts must have been the same.[2] The obvious difference is the appearance of the three-quarter obol in the interest amounts of the Other Gods (lines 54-97): five of the 20 interests which are preserved (at least at the obol end) show the two signs for the three-quarter obol; none shows the single sign for a quarter-obol. The further fact that the payment in line 87 is given an interest of one-half obol even though no imaginable kind of calculation could give this result in a system which recognized the quarter-obol makes it certain that the quarter-obol was ignored or rounded off to the unit or the half, even while the three-quarter obol was recognized. The reason for this distinction is obscure.

That not even the three-quarter obol was recognized in the recording of interest amounts calculated on payments from Athena Polias (lines 1-51) is made almost certain by the fact that of the 11 interest amounts which are preserved (at least at the obol end) not one shows the two signs for the three-quarter obol. Yet by the proportion of 5:20 in the accounts of the Other Gods, we might reasonably expect three out of these 11; even one would have been enough!

This one obvious difference between the two systems of bookkeeping requires at least one other difference, i.e., in the table of obol-equivalents, since one system recognizes only obols and half-obols while the other uses three-quarter obols as well. I am grateful to Pritchett[3] in this connection for pointing out what appear to be anomalies in my first, perhaps overly abbreviated, description of this stage in the calculations (*Hesperia*, XXXIII, 1964, p. 151). It now seems better to spell out in detail the most probable system of equivalence for the Other Gods, where the evidence is more nearly complete, and then to review the evidence for a different table for Athena Polias.

The exact decimal equivalents (to two places only) of the quarter-obols are as follows:

[1] See "The Abacus and the Calendar," *Hesperia*, XXXIII, 1964, pp. 146-167. I am happy to acknowledge a debt of gratitude to B. D. Meritt for criticisms and suggestions throughout. Appendix I is largely his work; any errors are my own.

[2] See Appendix II, pp. 243-247.

[3] *Hesperia*, XXXIV, 1965, pp. 131-147.

	unit	¼	½	¾
0	.00	.04	.08	.13
1	.17	.21	.25	.29
2	.33	.38	.42	.46
3	.50	.54	.58	.63
4	.67	.71	.75	.79
5	.83	.88	.92	.96

The five calculations for which all three terms (principal, days, interest) are preserved are as follows:

.04–½ obol (line 87)
.29–1¾ obols (line 86)
.38–2½ obols (lines 103 ff.)
.39–2½ obols (line 85)
.93–5½ obols (line 88)

Since the simplest method to arrive at results expressed in units, halves or three-quarters would be to round off to the nearest quarter, we should ask if this will work for the five calculations and (if it does) whether the one-quarter is rounded down to the unit or up to the half:

.04 is equal to .04 (¼) and is rounded up to ½;
.38 is equal to .38 (2¼) and is rounded up to 2½;
.39 is nearest to .38 (2¼) and is rounded up to 2½;
.29 is equal to .29 (1¾);
.93 is nearest to .92 (5½).

It is obvious that the quarter-obol is consistently rounded up to the half, but that there is not otherwise a tendency to round off upwards (rather than to the nearest) is shown by .93, which would then have been 5¾.

This system of obol-equivalence for the Other Gods will be subjected to further testing below (pp. 231-234); we should turn now to the chart previously presumed to have been used for the accounts of Athena Polias:

.01–.08 ½ obol
.09–.16 1 obol
.17–.25 1½ obols
.26–.33 2 obols
.34–.41 2½ obols
.42–.50 3 obols
.50–.58 3 obols
.59–.66 3½ obols
.67–.75 4 obols
.76–.83 4½ obols
.84–.92 5 obols
.93–.99 5½ obols

It is obvious that this table is inaccurate and inconsistent, with rounding upwards to the next half or unit up to .50 and rounding downwards to the next half or unit

from .99 to .50. The reason for this lopsidedness was the equality of the ranges, which not only seemed to be a desirable and equitable feature but also appeared to fit the calculations of Athena Polias' interest. Now, in view of the Other Gods' more certain system of equivalence, it seems reasonable to question this table. Since the Other Gods' use of the three-quarter obol shows that their system was more refined than that of Athena Polias, we should consider the possibility that their system of equivalence was also more refined, i.e., that Athena Polias' system was comparatively crude. A comparatively crude table which still used the principle of " rounding to the nearest " might well use the number at the middle of each range as the equivalent, thus:

.04–½ obol	.38–2½ obols	.71–4½ obols
.13–1 obol	.46–3 obols	.79–5 obols
.21–1½ obols	.54–3½ obols	.88–5½ obols
.29–2 obols	.63–4 obols	.96–6 obols

Before testing this table on the calculations of interest for Athena Polias, we should ask if there may have been other differences in the two systems of bookkeeping which might affect the results. It is necessary to ask this question because the whole method of abacus-calculation of interest was based on the examples for which all three terms were preserved, all of which happen to be payments from the Other Gods. We may, therefore, inadvertently have taken over in Athena's system of bookkeeping a practice or practices which belonged only to the more refined system of the Other Gods. One step in particular merits close consideration: the rounding-off of drachma-principals so that they will be divisible by three myriads. That the 1095/4 of lines 104-105 [4] was rounded up to 1098 drachmas was seen to be the one step necessary to give a calculated interest identical with that on the stone. It was perhaps a forgivable assumption therefrom that all drachma-principals were rounded up to the next multiple of three. But a closer look at this particular principal shows us that in one way it is unique: this principal is the sum-total of many individual payments from the treasuries of the Other Gods, so that the total interest must be certain to be equal to the sum of the individual interests which were owed to the individual treasuries. That is, it is right that this principal should be rounded off upwards, but if all the individual principals were similarly rounded off upwards the total might well not be sufficient to cover the sum of the individual interests. It is far more likely that as a regular practice individual principals were rounded off to the nearest multiple of three so that the roundings-off upward and downward would for the most part cancel out, leaving only a chance majority of roundings-off upward to be covered by the upward rounding-off of the total principal.

It seems desirable therefore to test out both the crude system of obol-equivalence

[4] See *S.E.G.*, X, 227 for this reading, which replaces the 1095/5 used in *Hesperia*, XXXIII, 1964, pp. 146-151.

and the practice of rounding off to the nearest multiple of three on the calculations for Athena Polias, especially since these differences may open the way to easier explanations of the errors immanent in the accounts of the first year. Take, for example, the third payment of Year I which that year's total requires to have been something over 28 T 5600. In the 1349 or 1350 days which this principal was outstanding the interest amounted to 1 T 1719/2, but as has frequently been shown this is not possible. Some error must be assumed, but the kind of error should be consistent with the method of calculation and arise naturally from steps which, when correctly performed, produce the correct interest amounts which appear on the stone. One possible error has already been suggested: "After the interest on the multiple of 5 T had been figured (25 T ÷ 5 = 5; 5 x 1349 days = 6745), the next step would ordinarily have been to take up to the board all the rest of the principal in drachmas to be divided by 3 myriads, but the auditor this time decided it would be well first to process the 3 T (18,000 drachmas) and the 3000 drachmas because of their easy divisibility: 21,000 ÷ 3 myriads = ,7000; ,7000 x 1349 days = 944/2 (944.30). But having removed the pebble against the 𐅵, he neglected to add two pebbles against the X and so having dropped 2000 drachmas out of the principal he went on . . ." (*Hesperia*, XXXIII, 1964, p. 155). Now we would have him go on to figure the interest on the amount of principal which would bring the interest to 1 T 1719/2; since the total interest on 28 T 3000 was 1 T 1689/2 (6745 + 944/2), we need principal productive of just 30 drachmas interest. The remainder which we require is 665 drachmas (665 ÷ 3 myriads = .0222, rounded off to the nearest; .0222 x 1349 = 29.9478, or 30, rounded off to nearest); 1 T 1689/2 + 30 = 1 T 1719/2. The neatness of this solution suggests that we are on the right track.

In order to get the interest on the stone (by using the crude table and by rounding off to the nearest multiple of three) we have arrived at a principal of 28 T 5665, of which only 28 T 3665 were actually used in the calculation. Can this principal have appeared on the stone not only in line 8 (its original appearance) but also as part of the first year total (line 15), as part of the four-year total (line 49) and as part of the eleven-year total (added to the previous seven-year total from lines 99-100 in line 114)? In line 8 the 28 T 5665 are one space short unless perhaps three of the broader letters are spread over four spaces; but the same six figures (the drachmas over and above the even number of talents) must appear again with no extra space in line 15, since all the other payments of the year add up to even talents. That is, the seven spaces for the drachmas in line 8 must carry exactly the same figures as the six spaces for the drachmas in line 15. In earlier reconstructions this discrepancy has been met by means of a principal ending in obols, the only signs which are sometimes doubled. These obols also served another purpose, i.e., to add with the obols at the end of the fourth year total (Years 2 and 3 have totals in talents only) to give a four-year drachma total which would fit into the eight spaces in line 49. We should now question

whether the obols at the end of the fourth year total are not a mistake. That is, the odd drachmas and obols of the fourth year total come from the fifth payment where there is an error which has been variously diagnosed: the 18 T which must certainly be restored give 122/2½ interest in the only possible number of days (34); if the principal was 18 T 122/2½, as the year's total seems to demand, the interest would have, by any kind of calculation and any table of equivalence, to be 122/3. Furthermore, the coincidence of a principal ending in the same eight figures as its interest is practically unbelievable, especially with the accompanying coincidence that the first year total would have had just the right number of obols and half-obols to combine with this figure to bring the four-year total out in even drachmas. It is far easier to believe that the last interest item crept into the year's total of payments but that the error went no farther [5]—perhaps because the Tamiai made the annual totals and the Logistai made the four-year total afresh from all the individual payments, and did not bother to check the individual year totals since nothing depended on them. So the Logistai would have added up all payments for the four years to get a total of 747 T 1185:

2 0 T
5 0 T
[2 8 T 5 6 6 5]
4[4]T 3 0 0 0
1 0 0 T
1[8 T 3 0 0 0]
3 0 T
1 0 0 T
[3 2 T 5 9 8 3/2][6]
[2 4 T 1 2 1 6/4][6]
[5 T 4 8]0 0
[1 0 0]T
5 9 T 4 7 2 0
2 T 5 5 0 0
[1 1 T 3 3 0 0]
1 0 0 T
[1 8]T

---

[7]4 7 T 1[1 8 5]

The drachma part of this total requires seven spaces, thus fitting into the eight spaces

[5] By this interpretation the phrase first suggested for line 46 by Meritt (*The Athenian Year*, p. 70) should be used here as well as in lines 33 and 39: τόκος τούτοι ἐγένετο. See *Hesperia*, XXXIII, 1964, p. 163 for rationale.

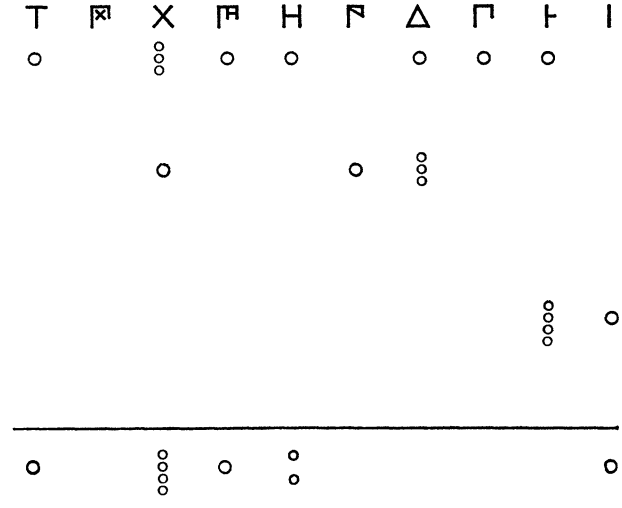
[6] For these readings, see *Hesperia*, XXXIII, 1964, p. 164.

at the end of line 49. This total may then be added to the 4001 T 4522 of lines 99-100 to give 4748 T 5707, the drachma part of which can easily be accommodated in the eight available spaces at the end of line 114.

If it is proper to interpret the error in the fourth year's fifth payment thus, the most difficult of the first-year problems, the third payment, is solved with only the one error of neglecting 2000 drachmas in the calculation. The difficulty in the first year's fourth payment is that the certain principal of 44 T 3000 gives in the equally certain number of days (1202) an interest which is at the same time too long (18-20 spaces) for the 10-11 spaces available and too little for addition into the year's interest total. What kind of mistake must be assumed to explain how the interest of 1 T 4697/5 could have been augmented by at least 2/1 to bring it at least up to the 1 T 4700 which is required by the available space? The only possibility seems to be that there was a slip in the manipulation of pebbles. The arithmetic was performed correctly as follows:

40 T in 1202 days = 1 T 3616
4 T 3000 in 1202 days = 1081.8

But when the second product (1081.8) was being added to the first, which was already posted against the opposite row of numerals, the crucial slip must have been made:



The last difficulty in the first-year accounts is in the sixth payment where a principal of 18 T 3000 must be outstanding for 1128 days. The interest on the stone is 4172/1 [plus, up to two spaces], although calculation by either abacus or decimal system gives 4173.60 or 4173/4. It is surely right to assume a stonecutter's lapse which turned the seven straight strokes at the end into two drachmas, five obols instead of three drachmas, four obols by the neglect of a single crossbar (𐅂 IIIII and 𐅂𐅂IIIII). The stonecutter's error would not have affected the total for the year:

[5 6 9]6
2 T 1 9 7 0
1 T 1 7 1 9 / 2
[1 T 4 7 0 0 / 1]
3 T 5 9 4 0
4 1 7<3>/[4]

[1 1 T 1]9 9 / 1

For the less problematical calculations of Years 3 and 4 the method which involves rounding off the drachma-principal to the nearest multiple of three and rounding off the hundredths to the nearest half-obol gives the following results (payments like both of those in Year 2 and one each in the other two years which are simple multiples of five talents need not be considered):

III.1 32 T 5983/2 in 707 days gives 4665.7758, hence 4665/5;
III.2 24 T 1216/4 in 611 days gives 2957.6066, hence 2957/4;
III.3 5 T 4800 in 545 days gives 632.2000, hence 632/1½;
IV.1 59 T 4720 in 355 days gives 4244.8415, hence 4244/5½;
IV.2 2 T 5500 in 281 days gives 163.9073, hence 163/5½;
IV.3 11 T 3300 in 252 days gives 582.1200, hence 582/1;
IV.5 18 T in 34 days gives 122.4000, hence 122/2½.

Differences from the previous reconstruction may be noted:

III.2—the interest is greater by ½ obol, which makes no difficulty either in line 31 or in the year's total in line 36;

IV.1 and IV.2 both give interests ending in 5½ obols; both of these interests fit on the stone, but the difficulty is that the two additional half-obols cause the total interest for the year to be 1 T 813/2½ instead of the 1 T 813/1½ which appears on the stone. Here we must take our cue from the other erroneous annual total in this year (the mistaken inclusion of IV.5's interest of 122/2½ in the payment total) which would not have been checked and corrected by the Logistai because the four-year total made it unnecessary. Presumably, the one obol of IV.3's interest was the one omitted. The four-year interest total in line 51 will thus be [1]8 T 393[8/2].

Thus by this revised method all calculations are completely consistent and the necessary errors not only arise naturally from the method of calculation but also are better motivated and do not involve the calculator in trying to correct an error in one pay-

ment by additional calculation in the next when it would have been more reasonable to correct the original calculation before the accounts were given to the stonecutter.

Turning now to the second half of the inscription we shall see that a further test of the Other Gods' system of equivalence (see above, p. 225) may be made by an attempt to restore some of the missing interest amounts or principals of the various items in the two payments made from the treasuries of the Other Gods in the fourth year of the quadrennium. The number of days during which the various items of the second payment were outstanding is known, both because the date is preserved (20th day of Prytany X) and because several of the items preserve both payment and interest (see above, p. 225) so as to make certain the 17 days from the 20th through the 36th of the prytany. Concerning the other, partially preserved items little can be added to the Meritt text, but the results of calculation by abacus and the Other Gods' system of equivalence are as follows:

line 80—4 T 1950 gives 14.70 or 14/4½;
2 T 5175/1 gives 9.73 or 9/4½;
line 81—any principal from 2844 to 2849 gives 1.61 or 1/3¾;
356/1 gives .2023 or /1½;
line 82—4 T 1527/4½ gives 14.46 or 14/2¾;
line 83—4749/4 gives 2.69 or 2/4½;
line 84—various amounts from 804/4½ to 840/4½ will both fit the space and give from .45 to .47 or /2¾;
line 89—353/2½ gives .20 or /1½.

Other items of this second payment are too fragmentary to allow of anything more than tentative restoration with so wide a range of possibilities as to be useless. It is worthwhile, however, to note the interest total on the whole second payment in lines 94-95; Meritt's restoration of the end of the principal is certainly correct (*The Athenian Calendar*, pp. 14-15), giving 23 T 5998; the interest total is preserved as 82; calculation on the abacus of interest on the sum of the payments is 81/3½, which proves that the total on the stone was arrived at by adding all the separate interest items rather than by a new calculation. This is only sensible since the interest calculated on the total would be of no value whatsoever when it was the individual amounts which had to be paid over. Furthermore, the total calculation shows that the rounding-off of principals to the nearest multiple of three and of interests to the nearest quarter-obol (except that the one-quarter was further rounded off to the half) resulted in an increment of 2½ obols (81/3½ + /2½ = 82).

The number of days during which the first payment was outstanding is more difficult, partly because the only part of the date preserved belongs to the civil calendar (line 58) and partly because no item preserves both principal and interest. It is possible, however, to arrive at successively narrower ranges of days in the following way:

first, the date must be in the first prytany (*The Athenian Calendar*, pp. 75-76), i.e., from 366 to 320 days before the end of the period; second, the calculation of interest on the 86 drachma principal in line 67 must yield a one-space interest, since Meritt's restoration of *Bendidos* in line 68 is certain. By all differing methods of calculation and approximation 86 drachmas must be outstanding from 356 to 340 days to produce one drachma of interest; decimal calculation gives from 1.0206 to .9748 for this range; abacus calculation gives from 1.0324 to .9860. This range is wider than necessary, for the sake of complete security. That is, because .04 in line 87 is called ½ obol, anything more than 1.02 here would certainly be 1/½; and as long as the three-quarter obol is recognized anything less than .98 would certainly be 5¾ obols.

Using the range of 356 to 340 days we may restore the first part of the total first payment (line 76) which produced interest of at least 2120 drachmas and not more than 2149/5¾. Rough calculations show that something over 31 T 1080 and under 31 T 3750 is required to produce this range in 340 days, and something between 29 T 4600 and 30 T 1170 will produce it in 356 days. The total range is from 29 T 4600 to 31 T 3750, but the subtraction of the mostly preserved second payment (23 T 5998 in lines 94-95) from the certainly restored drachma part of the year's total (5988 in line 96) requires that this payment end in 5990 drachmas. Restoring these figures in line 76 leaves only three spaces for the talent figure: [...𐅄𐅅HH] ΗΗ𐅄[ΔΔΔΔ] so that the only possible first payment total is 30 T 5990.

Using this total we may further narrow down the range of days to 346-342, since no other number of days provides an interest which will fit between the two extremes of 2120 and 2149:

30 T 5990 in 342 days gives 2120/¾ (.13)
in 343 days gives 2126/2 (.33)
in 344 days gives 2132/3½ (.53)
in 345 days gives 2138/4½ (.73)
in 346 days gives 2144/5½ (.93)

It is, of course, understood that it was not one of these interests which appeared on the stone, since this is the calculation of interest on the total payment, and what was useful for the auditors and treasurers was a total of the individual interests which because of rounding off to the nearest would have been slightly different from any one of these amounts, so that lack of space on the stone for 2138/4½ or 2144/5½ is irrelevant, since the total of individual interests in either of these cases might well have been 2139 or 2145/1.

These five possible numbers of days would give the following dates (line 58) in the calendar which is generally agreed on for the fourth year of the quadrennium:[7]

[7] All readings assume ἐχς Ὀπισθοδόμο.

342—I.25: allowing one blank space before first item, as in line 79;
343—I.24: allowing no blanks;
344—I.23: allowing two blank spaces;
345—I.22: allowing no blanks;
346—I.21: allowing two blank spaces.

All are epigraphically possible, even though I.25 is most elegant, so that we must consider restorations of the various individual interests or principals for all five. Calculations will be made by the abacus-method, with rounding off of principals to the nearest multiple of three and rounding off of interests to nearest quarter-obol (the one-quarter being rounded off to the half).

In line 67 the payment from Adrasteia of 86 drachmas gives the following interests:

346 days—1.0034	343 days—0.9947
345 days—1.0005	342 days—0.9918
344 days—0.9976	

All of these would be rounded off to one drachma.

In lines 66-67 a five-space payment from the Muses gives 6/2 interest (i.e., 6.31-6.35). The possibilities are:

555/4 or 556/2 (rounded to 555) in 342 days gives 6.32
in 343 days gives 6.34
553 or 552/2 (rounded to 552) in 343 days gives 6.31
in 344 days gives 6.32
in 345 days gives 6.34

All of these are possible, but 346 days can not produce an interest of 6/2 for any principal which can be fitted into the necessary five spaces.

Lines 68-69: it is practically certain that this Apollo was distinguished from the Apollo at Zoster in line 67 and the Apollo ——— in line 71. The epithet would have filled some of the 12 spaces between the god's name and *touto tokos*, leaving the remainder for the principal. Both otherwise and on the basis of *I.G.*, I², 310 the most likely epithets are Δελίο or Πυθίο (five spaces) or Παιῶνος (seven spaces); most important, however, is that there is no likely epithet of four spaces, so that the interest of 8 drachmas must derive from a principal of not more than seven spaces outstanding 342-346 days:

the only figures below 700 which yield 8 drachmas in any number of days are too long to fit into the space; e.g., 695 requires 8 spaces;
the lowest number over 700 which will fit the spaces is 702 (or what may be rounded off to 702), which yields 8.0028 in 342 days, 8.0262 in 343 days, 8.0496 in 344 days, etc.

Since it is most probable that 8.0262 would be rounded off to 8¼ and recorded as 8½, it seems clear that the combination of space-requirements and consistency of calculation allows for this payment only one number of days: 342.

Lines 69-70: the preserved interest of /1½ can come from the two-space payments, which must be 20 drachmas, in any number of days from 243 to 371, so that this particular payment is without evidential value.

Line 71: preserved interest of 129/3¾ must be derived from a principal which filled 15 spaces:

for 342 days, 1 T 5369/5 gives 129.6180;
for 343 days, 1 T 5337/5 gives 129.6197 (each obol must occupy a space);
for 344 days, no payment which gives the correct interest is long enough;
for 345 days, 1 T 5269/4 gives 129.6165;
for 346 days, no payment gives this exact interest.

Line 74: preserved interest of 20/½ suggests a payment of something less than 1800, which would give an interest of 20/3½ in 342 days and 20/4¼ in 346 days. Therefore, the preserved 600 of this payment should be restored with only one number (X) to the left, which gives 1600, and nine spaces to the right. These may be filled as follows for the various numbers of days:

for 342 days, 1759/4 gives 20.0754;
for 343 days, 1754/5 gives 20.0655;
for 344 days, 1748 gives 20.0552;
for 345 days, 1744 gives 20.0445;
for 346 days, 1737/4 gives 20.0334.

These are the only payments the restoration of which is clear enough to be useful. They do demonstrate the feasibility of the suggested system of obol-equivalence, which furthermore makes it possible to define the one day on which the first payments from the treasuries of the Other Gods must have been made: I.25, so that interest was calculated on 342 days (see particularly the payment from Apollo in lines 68-69). The number of days is the same as that established by Meritt (*The Athenian Calendar,* p. 76) by means of equations with the civil calendar, so that the present interest calculations help to confirm the civil-date restorations in lines 58 and 89. Because of the slight change in the composition of the fourth year since *The Athenian Calendar,* the prytany date is I.25 instead of Meritt's I.24; this allows a single blank space before the first payment here in line 59 as below in line 79 and permits the restoration of the source of the various payments (Opisthodomos).

The following are the changes and corrections to be introduced into the text of the Logistai inscription:

I

Variants from the text of *Hesperia*, XXXIII, 1964, pp. 165-167

Line 8: [νείας] τετάρτες πρυ[τ]ανευόσες [ἐσελελ]υθυίας πέντε ἐμέρας τῆς πρυτανείας 𐅄[𐅄𐅅TTT𐅆𐅅H𐅆ΔΓ ᵛ τ]

Line 10: [ευόσ]ες πέντε ἐμέρας ἐσελελυθ[ύας τῆ]ς πρυτανείας 𐅄𐅄𐅄[T]TTTXXX τόκος τούτο[ν ᵛTXXXX𐅅HHIᵛᵛ]

Line 14: [τοις] ἐγένετο XXXXH𐅆ΔΔHH<H>[IIII ᵛ κεφ]άλαιον τῶ ἀρχαίο ἀναλόματος ἐπὶ τῆς Ἀνδρ[οκλέος ἀρχῆς κα]

Line 15: [ὶ χσυ]ναρχόντον 5 ΗΗ𐅆𐅄T𐅆𐅅H[𐅆ΔΓ ᵛ τ]όκο κεφάλαιον τῶι ἀργυρίοι τῶι ἀναλοθέντ[ι ἐπὶ τῆς Ἀνδροκ]

Line 28: [τίδος πρυτανείας πρότες πρυταν]ευόσες hέκτει καὶ εἰκοστῆι τῆς πρυτανεί[ας ἐχς Ὀπισθοδόμ]

Line 29: [ο 𐅄𐅄TT𐅆𐅅HHHH𐅆ΔΔHHII τόκος το]ύτοις ἐγένετο XXXX𐅅H𐅆ΔΓ IIIII ᵛ δευτέρα δ[όσις ἐπὶ τῆς ....ί]

Line 30: [δος πρυτανείας τετάρτες πρυταν]ευόσες δοδεκάτει τῆς πρυτανείας 𐅄𐅄TTT [TXHHΔΓHIIII τόκος τ]

Line 31: [ούτον ᵛ XX𐅅HHHH𐅆Γ HIIII ᵛ τρίτε δ]όσις ἐπὶ τῆς Ἐρεχθείδος πρυτανείας hέ[κτες πρυτανευόσες]

Line 36: [χόντον TT𐅆HHΔΓIIII ᵛᵛᵛ τάδε παρ]έδοσαν hοι ταμίαι Τιμοκλῆς Εἰτεαῖος κ[αὶ χσυνάρχοντες ἐπὶ]

Lines 37-38: I owe to Geoffrey Woodhead the suggestion, which I accept as valid, that the end of line 37 and the beginning of line 38 should be read ἐγρ[αμμάτευε στρατεγ ▨ οῖς Εὐρυμέδοντι Θεοκλέος Μυρρ]ινοσίοι.

Line 40: [XXXXHHΔΔΔHHHIIIII ᵛ δευτέρ]α δόσις ἐπὶ τῆς Πανδιονίδος πρυτανεί[ας τρίτες πρυτανευ ▨]

Line 41: [όσες δοδεκάτει τῆς πρυτανείας] TT𐅆𐅅 τόκος τούτοις ἐγένετο H𐅆HHIIII[IIII ᵛ τρίτε δόσι]ς [ἐπὶ τῆ ▨]

Line 45: [πέμπτε δόσις ἐπὶ τῆς Λεοντίδο]ς πρυτανείας δεκάτες πρυτανευόσες τρ[ί▨▨ τ]ει τῆς πρ[υτανεί]

Line 46: [ας 𐅄𐅅TTT τόκος τούτοι ἐγένετο] HΔΔHHI ᵛ κεφάλαιον τῶ ἀρχαίο ἀναλ[όματος] ἐπὶ τῆς Τι[μοκλέο]

Line 49: [ος Ἀθεν]αίας ἐν τοῖ[ς] τέ[τταρσιν ἔ]τεσιν ἐκ Παναθεναίον ἐς Παναθέν[αια 3 𐅆] ΗΗ𐅄𐅄𐅄 𐅅TTX[H𐅆ΔΔΔΓ▨]

Line 51: [αια 𐅄]𐅅TTTXXX𐅅HHHHΔΔΔΓ[HHII ᵛ τάδε] Ἀθεναίας Νίκες ἐ[πὶ τῆς ▨ . . .⁶ . . ίδο]ς πρυτανείας [τετάρ ▨]

Line 52: [τες πρ]υτανευόσες τετάρτε[ι τῆς πρυτα]νείας Τιμοκ[λῆς Εἰτεαῖος καὶ χσυ]νάρχοντες πα[ρέδοσα]

Line 53: [ν 𐅅T τόκος] τούτοις ἐ[γ]ένετο H[HHHHI vacat]

II

Variants from the text of *S.E.G.*, X, *227*

Line 58: [*πρότες πρυτανευόσες hεκατομβαιῶ*]*νος ὀγ*[*δόει φθίνοντος πέμπτει καὶ εἰκοστῆι τῆς πρυτανε*]

Line 59: [*ίας ἐχς* ᾽*Οπισθοδόμο* ᵛ ᾽*Αρ*]*τέμι*[*δος* ᾽*Αγρ*]*οτέρα*[*ς* .....[40].....
.....]

Line 66: [....]ΙΙ(᾽*Αφροδίτες ἐν hιππολυ*[*τείοι* .....[24].....]
ΗΗΙΙΙΙΙ(ᵛ *Μοσ*[*ὸν* ΠΔΓ.. *τόκο*]

Line 68: [*Βενδ*]*ῖδος* ΠΔΔΔΓΗ *τόκος τού*[*το* Η .....[29].....]
Ι( )ᵛ ᾽*Απόλλον*[*ος* ..[5]... ΠΗΗ]

Line 69: [ΗΗ..]*τούτο τόκος* ΓΗΗΗ ᵛ [.....[36].....]
hερακλέος ἐν [*Κυνοσάργε*]

Line 74: [*τόκος το*]*ύτο* ΔΗ[.....[11].....Χ]ΠΗ[ΗΠΓΗΗΗΙΙΙΙ *τό*]*κος τούτο* ΔΔ
(ᵛ *Ποσειδῶνος Καλαυρε*[*άτο* ..[5]...]

Line 81: [.....[16]..... ΧΧΠΗ]ΗΗΔΔΔΔ[..[5]... *τούτο*] *τόκος* ΗΙΙ( )ᵛ *Διονύσο* ΗΗΗΠΓΗ *τόκος το*[*ύτο* Ι(.]

Line 83: [*το* ΔΗΗΗΗ( )ᵛ ..[5]...ΧΧ]ΧΧΠΗΗΔΔ[ΔΔΓΗΗΗΙΙΙΙ *τ*]*όκος τούτο* ΗΗΙΙΙ
(ᵛ ᾽*Αρτέμιδος Μονιχίας* [...[7]....]

Line 114: [᾽*Αθεναίαι Πολιάδι ἐν ἕνδεκα ἔτεσιν*] *τὸ ἀρχαῖον* [*ὀ*]*φέλοσιν*: ⋊⋊⋊⋊ΠΗΗΔ
ΔΔΔΠΤΤΤΠΠΗ[ΗΓΗΗ ᵛ]

Line 116: [*ἐν ἕνδεκα ἔτεσιν* ᾽*Αθεναίας Νίκες καὶ*] *Πολιάδος*:
[⋊⋊⋊⋊] ΠΗΗΠΔΔΠΤΤΧΧΧΗΗ[ΠΓΙΙ *vacat*]

Line 118: [ΔΔΔΓΙΙ(*vacat*]

APPENDIX I

Readings

The figure which Pritchett restores for the principal of the third payment of the third year is [ΠΤΧΗΗ]Ḥ!!.[8] This is on the edge of the stone in line 32 where the reading from the stone gives ΙΗ, two numerical symbols of which all the strokes of the final Η are preserved, or where not preserved unblemished preserved in the depths of the erosion which attacked this letter. The symbol before the final Η can only be part of another Η, but since only the right vertical stroke is preserved the double numeral should be read as [– – –]ḤΗ. This is true, no matter what the restoration. Meritt's comment on these readings in *The Athenian Calendar*, p. 27, does not need elaboration, but may now be supplemented by the enlarged photograph of the area of the stone in question published here in Plate 57.

[8] *California Publications in Classical Archaeology*, IV, 4, 1963, p. 304, with corrections which the reader must supply. He now considers ḤΗ and [Ι]!!! epigraphically possible; cf. above, p. 132.

Pritchett came late to his doubts about this figure, and sent a request by letter to John L. Caskey in Athens, who replied under date of March 8, 1949, giving what Pritchett calls " a careful description." What Caskey wrote was, in part, as follows:

> " The character before *tokos* in line 32 (*I.G.*, I², 324) can indeed be read as H, but in my opinion (based only on observation of the marble as there preserved) need not necessarily be read as H. The cross bar, if there was one, has been lost, the marble having been eaten away. I think I see a trace of the lower end of the right-hand vertical stroke of the alleged H, a sort of ghost preserved well below the surface and deeper than the original cutting can have been. Letters do weather that way sometimes, as Meritt remarks. I could see no ghost of the lower part of the left-hand vertical or of the cross bar."

So far as Caskey's description of the stone is concerned, it is substantially the same as Meritt's of 1928. He too observed " that the lower portions of the upright strokes are no longer preserved (except for the extreme tip of the left vertical bar).[9] The surface of the stone where the cross-bar of the H once existed has been completely destroyed by erosion."

Caskey's letter continues with an attempt at interpretation and with a sketch, which we shall discuss below. Pritchett claims that Meritt has misled him,[10] as demonstrated by his quotations from Caskey's letter, and he believed in 1947 that Meritt was the only scholar who had reported this critical reading as H. Pritchett pays no heed to the history of the text, and does not recall that the figure was read as H by two competent epigraphists, independently, years ago when the stone was first discovered. A. R. Rangabé so read it in 1838,[11] and he repeated the reading in 1842.[12] The earlier copy was accompanied by a good lithographic reproduction which shows not only the H but the right upright of the additional H just to the left of it. In both publications the cross-bar in the final numeral is clearly given. In 1842 Rangabé quoted the figure in his translation (*op. cit.*, p. 178) as 100 Dr. and had a note about it (*op. cit.*, p. 200): " Du capital on ne voit que les derniers 100 Dr." Pritchett now urges (above, p. 132) that on the question of this numeral " only reports of disinterested epigraphists can be accepted." He may think thus to bar Meritt's observations as evidence, but surely Rangabé in 1838 and 1842 should be sufficiently " disinterested " to satisfy the most incredulous. And, in any event, it is not the disinterested, but the experienced, epigraphist whose judgment must be sought. Of the six scholars cited by Pritchett now as admitting the possibility of reading three obols, only two are epigraphists and the drawing of the area in question presented in *California Publications* (IV, 4, p. 272) and to which Pritchett refers (until some petro-fabric examination of the

[9] Apparently not seen by Caskey.

[10] *California Publications*, IV, 4, p. 290. Cf. also p. 304.

[11] Ἐφημερὶς Ἀρχαιολογική, 1837 (No. 20). Though the issue which carries this inscription is dated in December of 1837, it must have been written and printed later in the following year, for the stone was discovered only in February of 1838.

[12] *Antiquités Helléniques*, I, p. 175 (No. 117).

stone is possible) was not made by either of these two. It is both inadequate and misleading in that it shows the area of the erosion as an undifferentiated blemish, whereas in fact the erosion follows the original strokes of the mason's chisel, not only in the cross-bar of the H but down both verticals (with the lesser eroded island between)[13] and then down to the short upright of the Γ and the upper half of the P in the line beneath. All this may be examined in the photograph on Plate 57, and is evidence that is not exhibited in the drawing in *California Publications.*

Pritchett has now examined the stone himself, and suggests (above, p. 131) that the stone " was damaged over a two-line surface and then the erosion took place." Surely, the erosion was the damage, unless in the strictly petrographic sense one wishes to count the chisel-strokes as " damage," for it is along these strokes that the erosion took place. He measures the " depth of this erosion as more than 0.002 m., much greater than that of the strokes of the letters." Naturally so; for this would be the inevitable effect of any erosion.

Nor does Pritchett acknowledge another expert and disinterested witness who years ago read this numeral as H. Ludwig Ross made a transcription of the text soon after it was discovered in the Erechtheion and on February 12, 1838 wrote a letter from Athens to M. H. E. Meier in Halle about it, sending also a majuscule copy along with his transcription. Meier published the letter and both copies of the text in the *Allgemeine Literatur-Zeitung* (No. 196) of November, 1838, and later made some comment upon it in the same month but in a later number of the *Zeitung* (No. 197).

Ross's letter was written only three or four days after the discovery of the stone, and his own commentary is very modest. He copied the numeral in question as ⋕, a mistake with which Pritchett will sympathize, for he has used the same symbol instead of H erroneously fifteen times in the two pages of his discussion of this text in *California Publications* (pp. 271-272). Yet Ross and Meier believed that the numeral was in reality ⋕. Important to us is that they had no doubt about the cross-bar. August Boeckh later acquired Ross's copy and used it in the preparation of his text for presentation to the Berlin Academy in 1846.[14] He wrote as follows: " Z. 32 ist das erste Zeichen bei Ross ⋕; dass dies falsch sei, zeigt schon der Raum, und die Rechnung würde es ebenfalls zeigen, wenn sie angestellt würde, was ich in dieser Partie unterlassen habe, weil die Rechnung weiter kein Ergebniss liefern kann. Rang. hat H, die Ephem. ˈH. Es ist unzweifelhaft H." This was repeated in Boeckh's *Kleine Schriften,* VI (1872), p. 90, edited by Ernst Bratuscheck and Paul Eichholtz, who appended a note on the figure: " Auch H kann aber durch die Varr. zweifelhaft werden, so dass

[13] Pritchett's claim that the island is too small to have any significance disregards the evidence, suppressing in words what the drawing suppresses as an illustration.

[14] *Abhandlungen der k. Akademie der Wissenschaften zu Berlin,* phil.-hist. Klasse, 1846, p. 371, with a majuscule text in Anlage B and a transcription in Anlage C.

darauf wenig zu gründen ist: nur H ist unmöglich." These doubts by the editors of Boeckh's *Kleine Schriften* were duly noted in Meritt's *Athenian Calendar*, p. 27, note 1. Meritt attached no importance to them then, nor does he now, in view of the obvious reading of the stone.

An attempt to trace down the variants is not without epigraphical interest. In the Ἐφημερίς of 1854 K. Pittakys read only II, but it is odd that he made no correction of Rangabé, inasmuch as the sole purpose of his publication was to search out and "correct" the errors of Rangabé. The bitterness of his feud almost guarantees that he would have "corrected" the H if he had noticed it at all. Kirchhoff in 1872 (*I.G.*, I, 273) published only II, which he may have had from Pittakys, but which he may also have seen (this and nothing more) on a squeeze made and sent to him by Koehler. Kirchhoff never saw the stone, and in this instance rejected the valid evidence of two reliable epigraphists who had. Kirchner in 1924 (*I.G.*, I², 324) read a dotted H. And here the matter rested until 1928 when Meritt again reported H, with a full epigraphic description of the letter, of the cutting, and of the weathering.

Meritt has consulted Günther Klaffenbach in Berlin about the squeezes that were available to Kirchhoff and Kirchner, and now has his letter of February 11, 1965, with his judgment, and the judgment of his assistants, on the better reading: "Der ältere Abklatsch, zweifellos derjenige, den Kirchhoff benutzt hat, entscheidet nichts. Er lässt sowohl die Lesung II wie H zu. Ich hätte an Kirchhoffs Stelle auch die Lesung II den Vorzug gegeben als der sicherer. Dagegen lässt der andere Abklatsch, also der, der Kirchner zur Verfügung gestanden hat, meines Erachtens keinen ernsthaften Zweifel an der Lesung H zu. Ich sehe den Mittelstrich ganz deutlich, vor allem wenn man den Abklatsch gegen das Licht hält, also bei transparenter Beleuchtung. Zur Sicherheit habe ich auch meine beiden Assistenten, Dr. R. Koerner und E. Erzleben, um Prüfung gebeten; sie bestätigen mir beide meine Angaben."

A word should be said about Pritchett's suggestion that a petrographic analysis might be of value.[15] We have consulted Professor Sheldon Judson of the Department of Geology of Princeton University about the possible effects upon the crystalline structure of the marble made by a chisel stroke in the cutting of a letter. His reply is as follows: "It is very unlikely that a chisel stroke would affect the crystal structure of the original marble. If it did, it could not be determined with an ordinary microscope or by X-ray studies. I cannot say what would be visible under an electron microscope, but it is doubtful if anything diagnostic would appear. This is, however, rather a futile discussion, because solution has removed so much of the original material that even if the chisel blow were to have affected the crystalline structure that evidence would have been lost long ago even on the edges of the best preserved characters."

[15] Above, p. 132.

METHODOLOGY

Pritchett appeals to " good methodology " to justify his disapproval of the Lang-Meritt definition of the right edge of the Logistai inscription from line 37 down to line 51.[16] Let it be said at once that any suggestion of *how* the damage along the right edge occurred is quite immaterial. The existence of some kind of obstruction in the way of inscribing complete lines of 75 letters is certain. Pritchett himself has restored two uninscribed spaces at the end of line 38, one at the end of line 39, two at the end of line 40, none in lines 41-42, two at the end of line 43, and five at the end of line 44.[17] This last is determined by his mathematical calculation of interest, and comes at a point where there is no question of the integrity of the right margin. But for lines 38-40 Pritchett has irregularities which are in principle no different from those posited by Meritt and Lang, and in line 43 he has an anomalous double-space uninscribed where they give a normal line. The difference in interpretation is that Meritt and Lang have the explanation of a damaged surface while Pritchett offers no explanation except whim, and he appeals to " similar financial records of the fifth century " [18] to show what vagaries the whim of the stonecutter might produce: " Here, as I have pointed out elsewhere, one sees that perfect stoichedon order was usually observed until one got to within three letter-spaces of the edge. Then irregular spacing occurs. Letters might be crowded or stretched out. Sometimes there was a desire for syllabic division; at other times there seems no obvious reason for irregularities." His references to *I.G.*, I², 295 and 304B are in no way pertinent to *I.G.*, I², 324. To determine how the stonecutter of *I.G.*, I², 324 dealt with the right margin one must look to what he did with the ends of lines 1-36. Here only once, at the end of line 17, was an irregular uninscribed space permitted. In other lines of continuous text there was no crowding, no stretching out, and no attention paid to syllabic division. The stoichedon pattern was strictly followed, and good methodology requires us to assume that such would have been the case in lines 38-40 had that been possible. Pritchett's " only acceptable methodology " is in fact a false methodology, and his suggestion that an " epigraphist who observes good methodology – – – must concede that any line, not merely the eleven of Lang and Meritt, may be within 2 or 3 letter-spaces of the normal 74 or 75 " violates every tenet of sound epigraphical practice in the reconstruction of this text.[19] He introduces us to a wilderness of error for which there

[16] Above, pp. 134-135. See the drawing in *Hesperia*, XXXIII, 1964, p. 162.

[17] *Calendars of Athens*, pp. 101-102.

[18] See also *California Publications*, IV, 4, p. 292. Such do not in fact exist. *I.G.*, I², 324 is the only Logistai inscription extant.

[19] An example of Pritchett's careless use of evidence occurs on p. 134, above, where he cites Meritt's restoration of the name Ἱπποθωντίδος in the ten available letter-spaces of *I.G.*, II², 358, line 2. What Meritt wrote was Ἱπποθ̣ωντίδος (*vel sim.*). He assumed an error that was corrected, and cited the parallel of *Hesperia*, VIII, 1939, p. 31 (No. 8). Pritchett suppresses the evidence of the parallel. But Meritt's scheme was only one way of writing the text. Perfect stoichedon order

is no evidence and no justification, either practical or theoretical; quite the contrary, for the areas in which Meritt and Lang have posited the damaged edge are guaranteed to have had abbreviated lines by a number of certain restorations of what the stonecutter had to cut and by his known habit of writing as evidenced in the upper lines. This applies also to lines 48-50, whatever may be the explanation of line 51. But Meritt and Lang have an explanation; Pritchett has none. He objects to their quite reasonable explanation, in part because they cite no " parallel, ancient or modern " for it, and he suggests that " any restorations which depend on such an unparalleled and unlikely theory be rejected *in toto*." He also claims to have " inspected myriads [20] of stones in the Epigraphical Museum in Athens and in the Agora Museum " and to have seen " no stele which supports Meritt's theory."

The theory of the damaged edge does not really require the citation of a parallel, but there are numerous instances in Attic inscriptions, overlooked by Pritchett in his search, where a blemish or damage to the stone has caused omission or misplacement of letters. Sterling Dow published two years ago eight (perhaps more) examples of uninscribed spaces caused by flaws in the stone: [21] *I.G.*, II², 226 lines 10 and 19, 654 line 37, 978 line 6, 1961 line 55, 2461 lines 9 and 11, 6217.[22] Dow missed the striking example of *I.G.*, I², 18 from the fifth century, though he searched Hiller's *Corpus* too. Here the flaw cuts across several lines and has caused omissions in double letter-spaces, as well as a number of displacements.[23] But Dow did not make claim to any kind of completeness, and, in our opinion, he was quite right in saying that a systematic search would hardly pay.

In sum, Pritchett's text of these truncated lines is itself truncated, and like the text of Meritt and Lang is conditioned by inevitable restoration. He merely rejects a reasonable explanation and prefers one which the opening lines of the inscription show to have been repugnant to the stonecutter of this particular text.

Other evidence for damage or blemish which interfered with regular stoichedon order in this closely restricted area near the ends of lines 45-51 is found in the date

can be preserved simply by omitting two letters. Since Dow's demonstration that *I.G.*, II², 358 belongs to the year 307/6 there is no slightest doubt that the archon was Anaxikrates, the month Elaphebolion, the prytany the tenth, and the name of the phyle Hippothontis. One explains the long name in the available space as best one can, but for Pritchett to call the doubling up of broad letters " Meritt's practice " is a perversion, and his suggestion that any restorer, following Meritt, would be justified in reducing or extending any line of *I.G.*, I², 324 by several letter-spaces is a logical *non-sequitur* which had best be forgotten. Pritchett, unhappily, comes back again to the restoration of *I.G.*, II², 358 in *B.C.H.*, LXXXVIII, 1964, p. 466, note 2.

[20] Surely an exaggeration.

[21] *Harvard Studies in Classical Philology*, LXVII, 1963, pp. 64-65.

[22] This may be seen in Kirchner's *Imagines*², No. 46, p. 18 (also in the first edition, No. 43, p. 16).

[23] See David M. Lewis, *B.S.A.*, XLIX, 1954, p. 22, and for a photograph see Hondius, *Novae Inscriptiones Attica*, fig. 1 (facing p. 3).

within the prytany for the last payment of 423/2 (line 46). This has been restored by Kirchhoff (*I.G.*, I, 273) as τ[ετάρτ]ει (one letter too short, but τ[ριακοστ]ῆι, one letter too long, involves mathematical impossibilities) and more recently by Meritt as τ[ῆι τρίτ]ει. But this involves the solecism of the definite article. Before it became apparent that the stone in this region had been damaged the claims of stoichedon order were strong, but now that we know of the damaged or blemished stone one must certainly read the numeral without the article. Epigraphically, this may be shown as τ[ρί▨▨τ]ει. It is, of course, quite uncertain where the blemish fell. Earlier editors have read, after the initial tau, part of an epsilon or rho, of which nothing is now preserved on the stone. The stroke may have been on the very edge, and if one takes account of it (see especially the majuscule text of *I.G.*, I, 273) the text should be read τρ[ί▨▨τ]ει.

Our belief now is that the damage or blemish of line 51 occurred in the name of the phyle rather than in the numeral at the end of the line. Meritt had restored the numeral as τετάρ▨|τες. Lang's text has given τρί▨▨|τες. We now prefer to keep τετάρ▨|τες and let the name of the phyle (of the fourth prytany) be the same as in line 42 where only ten letter-spaces are available for it: Erechtheis, Kekropis, or Antiochis. In line 51 the ten-letter word occupied eleven spaces, one of which (uncertain which, except that it was not the final sigma) was a damaged or blemished spot upon the stone. The payment from Athena Nike was thus made on the same day as the third payment from Athena Polias and was supplementary to it. In neither case can a phyle with eleven letters (Akamantis or Pandionis) be restored, for these two were the first and third prytanies of the year. The Meritt-Lang division of τε|ς in lines 41-42 is justified, and is part of the general evidence for blemish and damage in this neighborhood.

One other question of methodology deserves to be mentioned. Pritchett has insisted that the only part of *I.G.*, I², 324 which can be used as evidence for the prytany calendar comprises the preserved portion. Only the preserved portions, he says, can be used for historical evidence.[24] The matter is less simple than this, and with sound methodology one might rightly insist that even some restored portions have the validity of fact. One illustration will serve to establish the principle. In the record of the fourth payment of the third year (line 33), for example, the sum of 100 talents was loaned on the 30th day of the eighth prytany, and the name of that prytany was Akamantis. Of all this only the word τριακοστῆι is preserved on the stone. But the amount of the principal and the name and number of the prytanizing phyle are absolutely certain, the principal from the internal evidence of the inscription, and the facts about the phyle from a comparison with Thucydides (IV, 118) and again from the internal evidence of the inscription itself. The interplay of mathematical equations

[24] *Calendars of Athens*, pp. 104-105; *California Publications*, IV, 4, p. 291.

and the necessities of epigraphical restoration make the usual rule, that only that which is actually on the stone has value, quite inadequate.

APPENDIX II

Pritchett's assumption (*Hesperia*, XXXIV, 1965, p. 131) that " his opponents " introduce irregularities into the text wilfully and at random leaves out of account not only the aims and intentions which they cherish but also the anomalies and irregularities present in the text which they feel it their responsibility to account for in a reasonable and consistent fashion. Given, for example, an error in calculation, one attempts to explain or motivate it by showing how it might have arisen from a given set of circumstances and from the particular methods of calculation applied throughout the text. This is not to invoke an arbitrary and capricious chance to explain the error but rather a sober effort to define a consistent system of ways and means which could have given rise to all the results we find in the text—to the right answers when it worked, and to the errors when it broke down. The important thing is that one voluntarily puts on, in order to see the record steadily and see it whole, a theoretical straitjacket which closely confines the range of hypothesis to an ordered and consistent system.

Concerning calculation of interest by means of the abacus Pritchett has many objections. I do not apologize for hypothesizing mistakes made by the operator; where there is clear and sufficient evidence that arithmetical mistakes were made, it seems to me more constructive to show that the abacus lends itself to the kinds of error required than to object to calculations which allow errors.

In his consideration of Year 3 Pritchett indulges in irresponsible exaggeration by suggesting that the lengths of the various lacunae can be permutationally combined to allow myriads of possible restorations. Yet he knows from his own attempts to restore the accounts of this year that the interdependence of dates, payments and interests is so limiting a factor that each letter or figure restored reduces materially the possibilities for every other space in the various lacunae. He goes on to say, " Since Lang assumes six errors in 12 payments of Years 1, 2 and 4, the law of averages requires us to accept the possibility that there were two errors in the four payments of Year 3." Aside from the fact that the " six " errors represent a very special way of counting five errors,[25] all of which are required by the surviving text, as Pritchett has implicitly admitted in accepting Meritt's Year 1 and the last payment of Year 4,[26] this invocation of the law of averages attacks the very foundations of

[25] In Pritchett's list of errors nos. 1 and 2 are exactly the same: the omission of 2000 drachmas of the principal in the calculation of interest.

[26] *Calendars of Athens*, p. 96, pp. 101-104. Also, " we must recognize that there were at least two errors in the numerical notations in this document " (*loc. cit.*, p. 104).

epigraphical science. Unique expressions must be accepted in preserved texts, as here in Years 1 and 4, but do not give *carte blanche*, in arithmetical proportion, for errors elsewhere.

Pritchett's objections may be met or disposed of under the paragraph numbers which he uses.

1. That a 4th century A.D. mathematician like Theon of Alexandria could handle long division " on paper " is no guarantee of similar knowledge or skill on the part of plain 5th century B.C. citizens holding office. What Pritchett calls the " inefficient system " of rounding-off is actually the best method of cutting out endless fractional calculations which are for the most part too small to be reflected in a system of notation based on the half (or even quarter) obol. That is, it is only for a number of days as great as the 1464 of lines 102 ff. that rounding up from 1095/4 to 1098 produces as much as three-quarters of an obol.

2. Proving the system of abacus-calculation on material which requires no restoration is a counsel of perfection rendered impossible of achievement by the lack of comparable material of such a sort. The Delian records to which Pritchett refers supply neither the number of days loans were outstanding nor the amount of the loans; not even the rate of interest is known; there are only the interest amounts.

3. Pritchett refers to my earlier mention of abaci different from that of Salamis (*Hesperia*, XXVI, 1957, p. 282) and asks what results they would yield. Had he read more carefully he would have seen that the other abaci are those with labelled columns which are completely satisfactory only for addition and subtraction, so that using them for the multiplication of the Logistai inscription would be only confusing.

4. A similar lack of understanding allows Pritchett to accept Wyatt's abacus (*Classical Journal*, LIX, 1964, pp. 268-271) with its unlabelled obol column as explanation of the error in Herodotos II, 142. An abacus which allows columns to be 1000, 100, 10, 1 and then 1/6 is bound to cause trouble because the columns are really like the zeroes in our decimal notation, and a sudden shift to another system can produce havoc unless the columns are obtrusively labelled.

5. and 6. Neither the decimal nor the duodecimal system of abacus calculation hinges on the median line of the Salamis stone, since there is nothing to prevent the use of nine (or 11) pebbles to a column. The median line makes it possible to use fewer pebbles, allowing one pebble above the line to represent five of those below. So, for example, it is possible with the median line to represent 5000 drachmas with the same one pebble in the calculating area as was used to represent it over against the 𐅅 in one of the side rows of numbers. As was clearly stated in *Hesperia*, XXVI, 1957, pp. 278-282, Nagl rejected the idea of a decimal-system abacus because of one marble counting-board (*ibid.*, p. 276, note 12, no. 9) with the columns marked 𐅀𐅅𐅄 etc. He thought that all abaci must work on the same principal and follow this

example in having columns alternating in value between 5 and 2 (i.e. 5 hundreds are equal to 1 five-hundred; 2 five-hundreds are equal to 1 thousand). But it is neither right nor necessary to assume that abaci with unlabelled columns are operated in the same way as one with labelled columns. The latter is a scoreboard which is completely adequate only for straightforward addition and subtraction of pebbles, but the former is an adaptable machine capable of performing any arithmetical operation.

7. The three x's of the Salamis stone could have been used in some operations to mark the right ends of the various terms. That they are not, for the most part, useful for this purpose in the calculations of interest for the Logistai inscription (because of the large numbers involved) does not invalidate either the stone or the calculations. Any abacus will not have been limited to one type of calculation and so will have been equipped for a variety of purposes.

8. Pritchett, apparently assuming that the Salamis stone was specifically created for Tamiai and Logistai to use in their interest calculations for *I.G.*, I^2, 324, complains that I have " adapted " the numbers for my purposes. But surely no one could imagine (except perhaps for the sake of argument) that coincidence would preserve for us on the island of Salamis the abacus which Athenian officials used in the year 426/5 and following. I wished merely to use the Salamis stone as an actual, sample abacus and to have the kinds and numbers of symbols which the officials seem from their records to have used.

9. In the next breath Pritchett asserts that the Salamis stone is no abacus at all. Apparently its heaviness and virtual immobility are a disadvantage and a black mark against it in his eye. But surely nothing could be more convenient in the market place than a permanent calculating board, to which all and sundry could repair to settle a financial argument in plain and public view.

10. The presence of semicircles or ellipses on the Salamis stone which I have not used in my calculations nor attempted to explain may indicate uses for the stone not yet envisaged, but I do not understand why it should be thought that they fit better into a gaming context than into that of calculation.

11. Prichett's insistence that the Salamis stone and other similar stones are all gaming boards seems to me unnecessarily exclusive. The form may in origin have been either for the purpose of calculating or for the use of gamblers. But in its development it is perfectly reasonable to expect that both uses may have flourished side by side; sanctuaries were equipped with the stones perhaps for business purposes but idle hands soon found a way to use them for pleasure; or gaming facilities presented a convenient set-up for arithmetical calculations. At any rate, the variety of functions fulfilled by the stone is not of such immediate concern to us as the fact that we can demonstrate the way in which it could have been used as a calculating board; the fact that the gaming possibilities are less demonstrable may make its identification as a gaming board and nothing but a gaming board more attractive to some.

12. The discussion above (pp. 224-226, 231-234) demonstrates the use of the abacus on the accounts of the Other Gods.

13. The fact that the abacus-calculation requires a rounding-off of the drachma principal to a multiple of three does indeed mean that complete accuracy in recapturing the principal is impossible, but it is a rare situation where the demands of space on the stone combined with the limits imposed by both one-year and four-year totals do not further limit the principal to one particular amount within the comparatively small range of inaccuracy: three drachmas.

14. Even when the number of days during which the loan was outstanding was small, so that (to take Pritchett's example) any principal from 60 drachmas to 150 drachmas will give an obol for 30 days, other factors like space and totals may help toward a closer definition. Pritchett instances the fifth payment of the fourth year as if the fact that any sum between 17 T 5947½ and 18 T 8/4½ gives the interest on the stone for 34 days left one to choose one of the intervening figures at random. Again the year's total and the spacing combine to make any principal other than 18 T impossible.

15. The discussion above (pp. 224-234) gives further explanation of the methods which may be assumed for the handling of obols and other fractions of the drachma. Only such conversion tables can explain the discrepancies on the stone from results calculated by the decimal system, since the abacus gives decimally correct results and thus requires that at least one step in the calculation be *extra abacum.* The presence of the eighth-obol on the Salamis stone tells us nothing of the Logistai's interest calculations since there is no reason to believe that this stone (or any other abacus) was limited to only one operation. It is perfectly possible that arithmetic dealing with obols employed a table in which conversions were provided for eighths.

16. The asymmetry in my earlier table of obol-equivalents is both explained and modified above (pp. 225-227).

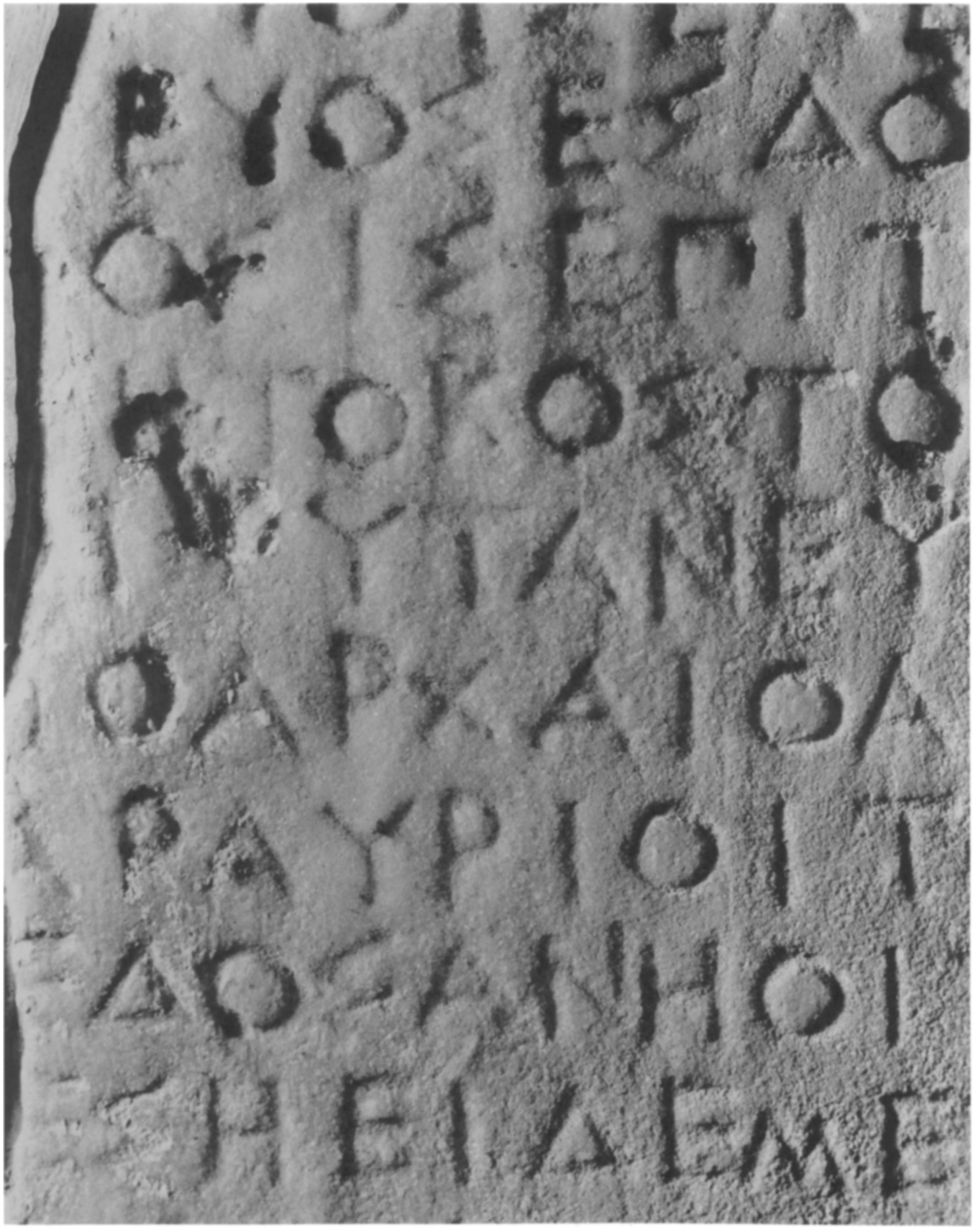
17. The above (pp. 227-230) revisions in the errors which must be assumed from the preserved text seem a sufficient answer to Pritchett's objections to the inexpertness of the abacus-operator. These revisions were made possible by the new insight into the ancient practices of rounding-off and obol-equivalence gained from the accounts of the Other Gods. Pritchett's plea for rule-of-thumb computation is perfectly sensible, but should be implemented with a rule of thumb which explains both the errors and the right answers on the stone as well as our abacus calculations can do.

When Pritchett suggests (pp. 145-147) that annual boards had calculated interest, it is difficult to decide whether he means that the board of Year 1 knew the end of the period to which it was calculating three years in the future or whether he thinks that the board calculated interest only to the end of its own year, leaving the next board to calculate its payments for their year, and so on. Both alternatives seem

to me highly improbable: not only is the forecasting of three more years of 366 days each hard to imagine if the prytany calendar is in some way connected with the solar year, but also the whole idea of anticipating interest for a future unforeseeable seems both un-Greek and unbusinesslike; if the interest on Year 1's payments was calculated by the Year 1 board only for Year 1, and so on throughout the four years, we would surely have a different arrangement of the accounts than the Logistai inscription provides. That is, instead of the quadrennial interest for each payment and for each year's payments we should expect 1) interest for each payment of Year 1 only for Year 1; 2) total of Year 1's interests for the Year 1; 3) for year 2 the same and then total interest on Year 1's payments for Year 2; 4) for year 3 the same and then total interests on Years 1 and 2's payments for Year 3, etc.

MABEL LANG

BRYN MAWR COLLEGE



Part of *I.G.*, I², 324, lines 30-37