TWO DEMOTIC ASTRONOMICAL PAPYRI IN THE CARLSBERG COLLECTION

BY

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Recently in the *Journal of Near Eastern Studies* I published a demotic mathematical papyrus fragment as the first of its kind, with a footnote that there were some fragments of geometrical texts in the Carlsberg Collection of the University of Copenhagen which were to be published by Dr. Aksel Volten.¹ Early in 1960 Dr. Volten wrote me that he had no plans to publish the fragments and would be glad to have me do so if I wished. I agreed immediately and in due course excellent photographs arrived.²

The fragments numbered fourteen in all and it was evident at first glance that they were not all from the same papyrus nor in the same hand. With study four separate papyri were discernible, (with three small unassignable fragments over) two of which form the subject of this article. Of the other two, *P. Carlsberg* 30 consists of two fragments with geometrical figures and scanty texts on the recto and a mathematical exercise involving proportions of silver, gold, bronze and lead on the verso;³ and *P. Carlsberg* 33 consists of four fragments of a grain account and is non-mathematical.

P. Carlsberg 31 is made up of four fragments, two of which fortunately join. The fibers of the other two agree well with one another when placed as in the Plate and the reconstituted text assures the accuracy of their position. The verso is almost in-

¹ *JNES* 18 (1959), 275, n. 1.

² I should like to express my deep appreciation to Professor Sander-Hansen and to Dr. Volten for the photographs and permission to publish the texts.

³ Because of some technical terms *P. Carlsberg* 30 is to be published with or after a British Museum mathematical papyrus which I am presently studying.

decipherable but Volten has recognized the words *ipt*, "work" and *iw*, "old age," which suggest to him a wisdom text. The recto, however, has a new and unique text with vertical columns of numerals having a horizontal entry opposite every fifth numeral. In the one instance where the essential word is preserved in full (IV,10) it is clearly *rnpt*, "year". The numerals after *rnpt* in col. II are *45t* and *50* and in col. III are *65t*, *60*, and *75t*. The fact that *rnpt 45t* in col. II is opposite *rnpt 75t* in col. III makes it clear that each column covered thirty years.

The next fact which can be won from study of the scanty text is that the numerals in the columns decrease by 22 and when it becomes necessary to subtract 22 from a smaller number 129 is added as module. Thus we have in II: 86, 64, 42, 20 (+129), 127, 105, 83, etc. From these data it is easily possible to reconstruct the entire text as a cycle of 129 years. The result is given in Fig. 1 within the double lines, with the preserved text in bold face so that it may be readily picked out.

Unfortunately, while the whole cycle can thus be reconstituted, its purpose remains obscure. Neither I nor my colleague, Professor O. Neugebauer, who ransacked his extensive files of astronomical data in my behalf, have been able to suggest for what it was used.

The same unhappy conclusion comes about after study of *P. Carlsberg* 32, which can also be reconstituted as an astronomical table of unknown application. The single preserved fragment has the remains of two columns of numbers in the sexagesimal system, with horizontal lines separating the numbers into groups of five.

I did not expect sexagesimals as they have not previously been noted in demotic and I have Neugebauer to thank for recognizing them and establishing as well the construction of the table. The base number is 0,5,27,17. In col. I this is simply added cumulatively, while in col. II the totals of the cumulative numbers are given, line by line. The reconstituted table is given in Fig. 2 between the double lines, with the preserved text in bold face. The column to the right gives the number of times the base has been multiplied to reach the corresponding total in col. II. In the original, to be sure, the table may well have had more than 20 lines.

For zero the scribe used a short dash, as may be seen in I, 6, 7, 11 and II, 4. It is interesting that he used it at the beginning of a number as well. Curious, also, is the use of w' for 1 in I, 12 (and probably 14) and II, 5 and 6, at the beginning of a number only.

Like many other Carlsberg papyri, these fragments come from Tebtunis. Their date cannot be fixed with much precision by palaeography alone, though the Roman period is certainly to be preferred to the Ptolemaic. I have not found elsewhere the unique writing of 30 in *P. Carlsberg* 31; but since the bulk of the Carlsberg papyri date to the middle of the second century A.D.⁴ it is reasonable to assume that both our present ones date to that time as well.

I hope that with the publication of these fragments some one of our colleagues will be able to offer the explanation of their tables that has so far eluded both Neugebauer and myself.

⁴ A. Volten, *Archiv Orientalní* 20 (1952), 496.

Note to the Foregoing.

My article was already in proof when Neugebauer informed me that he had solved the riddle of *P. Carlsberg* 32. According to him it is a short section for the day-by-day motion of Mercury, specifically between stationary point and last visibility as morning star. The method is well known from Babylonian texts. There is a close parallel in Neugebauer, *Astronomical Cuneiform Texts* III, Pl. 169, No. 310 Rev. I lines -3 to 16. The first difference in *ACT* 310 is $0;5,45^\circ$ whereas our text has $0;5,27,17^\circ$. The Babylonian tablet is computed for a specific date whereas our text is probably a general scheme, to be modified slightly for practical cases (cf. *ACT* II, p. 327).

Neugebauer remarks further that a very similar Greek text has just come to light, using the same arithmetical method for the daily motion of Saturn. It will be published in the next volume (15) of *Papiri greci e latini, Pubblicazioni della Società Italiana...*

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	I	II	III	IV	V
	(year 0 129 or 0)				
	107	92	77	62	47
	85	70	55	40	25
	63	48	33	18	3
	41	26	11	125	110
5.	year5 19	year35 4	year65 118	year95 103	year125 88
	126	111	96	81	66
	104	89	74	59	44
	82	67	52	37	22
	60	45	30	15	129
10.	year10 38	year40 23	year70 8	year100 122	
	16	1	115	100	
	123	108	93	78	
	101	86	71	56	
	79	64	49	34	
15.	year15 57	year45 42	year75 27	year105 12	
	35	20	5	119	
	13	127	112	97	
	120	105	90	75	
	98	83	68	53	
20.	year20 76	year50 61	year80 46	year110 31	
	54	39	24	9	
	32	17	2	116	
	10	124	109	94	
	117	102	87	72	
25.	year25 95	year55 80	year85 65	year115 50	
	73	58	43	28	
	51	36	21	6	
	29	14	128	113	
	7	121	106	91	
30.	year30 114	year60 99	year90 84	year120 69	

II, 19: Text has 84. II, 20: 1 is blotted. V, 9: or 0.

Fig. 1. *P. Carlsberg* 31 reconstituted.

(Preserved text in bold face)

	I	II	
	0, 5,27,17	0, 5,27,17	1
	0,10,54,34	0,16,21,51	3
	0,16,21,51	0,32,43,42	6
	0,21,49, 8	0,54,32,50	10
5.	0,27,16,25	1,21,49,15	15
	0,32,43,42	1,54,32,57	21
	0,38,10,59	2,32,43,56	28
	0,43,38,16	3,16,22,12	36
	0,49, 5,33	4, 5,27,45	45
10.	0,54,32,50	5, 0, 0,35	55
	1, 0, 0, 7	6, 0, 0,42	1, 6
	1, 5,27,24	7, 5,28, 6	1,18
	1,10,54,41	8,16,22,47	1,31
	1,16,21,58	9,32,44,45	1,45
15.	1,21,49,15	10,54,34, 0	2, 0
	1,27,16,32	12,21,50,32	2,16
	1,32,43,49	13,54,34,21	2,33
	1,38,11, 6	15,32,45,27	2,51
	1,43,38,23	17,16,23,50	3,10
20.	1,49, 5,40	19, 5,29,30	3,30

I, 5: Text has 36 for 16.

Fig. 2. *P. Carlsberg* 32 reconstituted.

(Preserved text in bold face)