Quantitative Properties of the Karanovo Calendar

Dipl.-Ing.(FH) Kapt.(AG) Wolf Scheuermann
Forschungskontor

Version 1.2
Hamburg, 2017

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1 Introduction

On the bottom of a furnace clay model of the Karanovo culture (5th millennium BC) is a kind of table, which is addressed by the researchers as a calendar [1].

In the first article on this object [2] we examined the preparation of this table, without going into the possible content. It was found that the table, which contains only framing lines and entries of longitudinal and horizontal lines, but no characters, was engraved in a single operation prior to the ceramic firing.

In this document, a substantial consideration should now be based on the quantitatively observable facts.

2 Appearance of the Table

Figure 1: *The Karanovo table,* © *Lessing Archiv.*

We consider the table (Figure 1) in the reconstructed abstract form (Figure 2), with the orientation first of all left out, even if the history of manufacture (see [2]) suggests the orientation shown here. Quantitative properties are invariant to rotation and reflection.

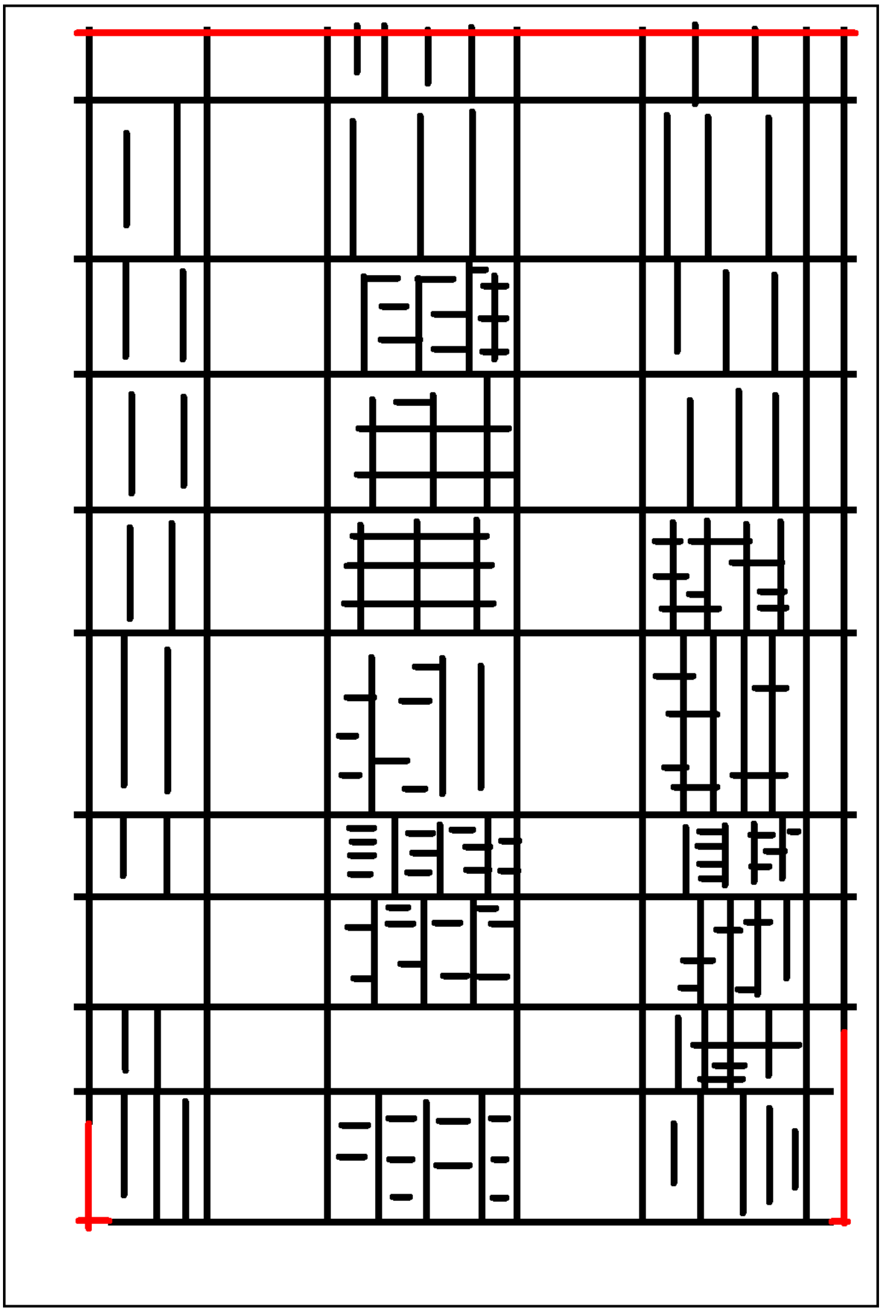

Figure 2: *The Karanovo table, abstracted.*

3 First Observations and Assumptions

1. Due to the speedy manufacturing process, the content or appearance of the table may have already been established prior to scoring into the bottom of the oven model.

2. The contents of the table seem to have been so important that it was worth keeping on a durable material like ceramics.

3. The contents of the table (the longitudinal and horizontal lines of different lengths within the frame lines) do not correspond to characters of the Donauschrift. Therefore, it may be numbers or counts in the context of the fields.

4. The (restored) table consists of 6 columns and 10 rows, therefore 60 fields (Figure 3). However only 3 columns show labeled fields. The empty columns only appear to be separations, with the last column boundary also being added last and this void column being narrower than the others. There are thus 30 fields that have any meaning, but 3 fields of them are empty. Only 27 fields really contain entries.

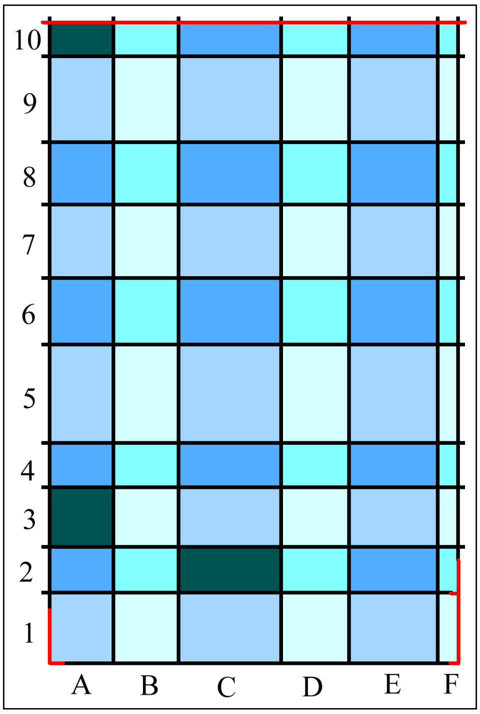

Figure 3: *Partitions of the Karanovo table.*

What could this table be about? The following uses might come to mind:

- Bread issue to clans?
- Census?
- Abacus?
- Cadastre?
- Music Score?
- Dance steps for ritual dances?
- Menstrual cycles?
- Day count / -calender?
- Lunar calendar?
- Others?

The number of 27 fields with entries let one actually think of a calendar, and also a lunar calendar, because the so-called sidereal month, i.e. the time of an inertial moon orbit, or the time until the moon passes the same fixed star, is 27.3217 days.

This would mean, however, that at the time of manufacturing of the table already a considerable empirical knowledge about astronomical movements and a long-term data collection was available. Were there for the early farmers of the Danube civilization to which the Karanovo culture belonged (the predecessors of the band ceramists) a necessity and use of such knowledge?

4 Timing in Agrarian Cultures

The people of Karanovo culture were settled farmers. For agriculture is time management, and therefore timekeeping, an important aid. But how does one measure time without instruments?

Timing consists of counting periodic events. For observers without instruments, counting is the only remedy. The (apparent) solar course (actually the synodic rotation of the earth around its axis) determines the cyclic change day and night. This cycle defines the smallest unit of time that can be counted precisely without any equipment, the (whole) day. But you can also count the light and dark cycles: a day thus consists of two half-days.

The next cycle that is easy to observe is the change of the moon phases. The days from full moon to full moon can be easily counted, better yet, because to see more accurately, from a quarter moon to the same quarter in the next cycle. This results in the Synodic Month, also called Lunation of about 29.52986111 days.

In higher latitudes, seasonal cycles (summer / winter) are noticeable, but they are too blurred to be fixed by counting days. The obvious repetition of year-round changing sunrise and sunset points are also not securely detected without fixed direction finder (palisade or stone circles). But the long-term unit year can be defined in the long term. The duration of a year in days can also be determined by long-term data collection. A so-called Tropical Year is defined as 365.24219052 days, so it has about 365.2422 days, as reflected in the switching rules of our calendar.

An attentive observer of the star sky will notice more phenomena: he will see the daily motion of the moon in front of the fixed star background. In addition, he will find that during several lunations the Moon passes the same stellar constellations fairly regularly. This period, the inertial circulation of the moon, is called the sidereal month and is noticeably shorter than the synodic month, namely 27.321661 days. Longer-term observation yields this number.

Of the other astronomical phenomena that are easy to observe with the naked eye, very few are useful for timekeeping without aids: the fixed starry sky, which turns slowly in the annual course, is badly suited for measuring time without a fixed reference point, but underpins the concept of the year as time unit. The visible planets may have appeared unsuitable for timing due to their irregular motion.

Finally, there are the inexplicable and perhaps even terrifying lunar eclipses, which are apparently sporadically easy to observe during the full moon. This calls for explanatory tests and predictions outright. Incidentally, lunar eclipses are much easier to observe than solar eclipses, since only the total solar eclipses, which are very rare in one place, can be perceived by the naked eye.

5 Quantitative Properties of the Table

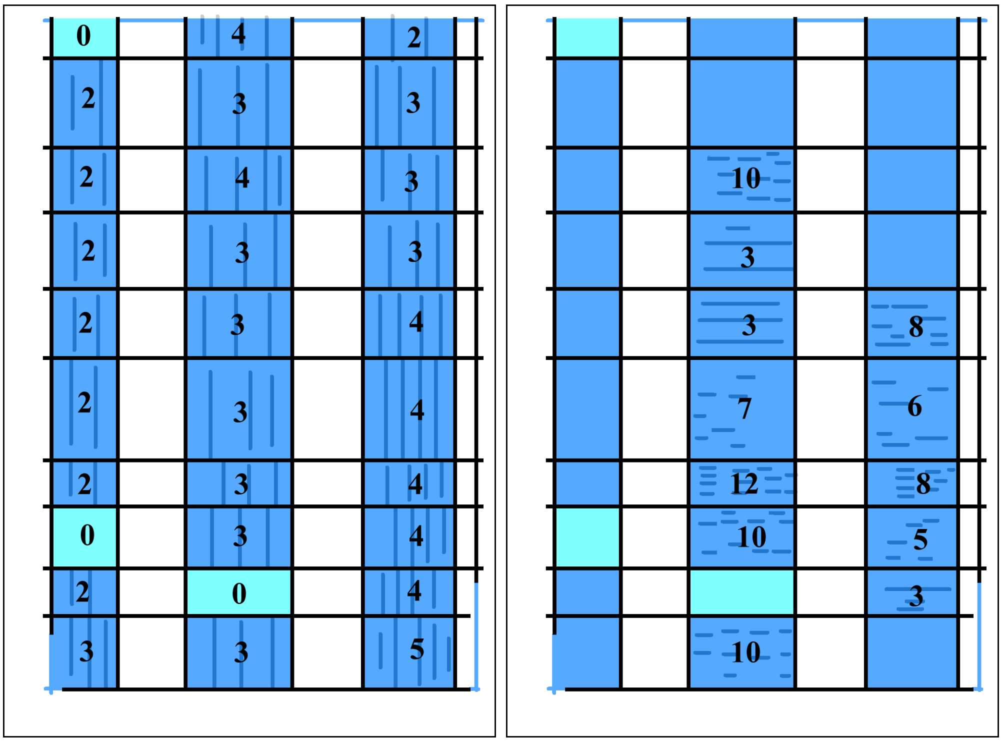

Figure 4: *Entries in the Karanovo table: vertical (left), horizontal lines (right).*

The table consists of 6 columns and 10 rows. But only 3 columns (A, C, E) show entries in vertical and horizontal, long and short lines. The fields A3, A10 and C2 are empty, so that only 27 fields are really labeled.

We distinguish vertical lines and horizontal lines (Figure 4). There are different lengths of horizontal lines that cross the vertical lines or are in the spaces or are connected to a long line, but this should be disregarded for the time being.

The counting gathered into a matrix:
1. component: vertical lines
2. component: horizontal lines

Row \ column	A	C	E
1	(0,0)	4,0	2,0
2	2,0	3,0	3,0
3	2,0	4,10	3,0
4	2,0	3,3	3,0
5	2,0	3,3	4,8
6	2,0	3,7	4,6
7	2,0	3,12	4,8
8	2,0	3,10	4,5
9	(0,0)	(0,0)	4,3
10	3,0	3,10	5,0

First to the positions of the empty fields. The empty fields appear (depending on the method of counting) in the following places:

Counted line by line (forward and backward):
(A1=1, C1=2, E1=3, A2=4, etc.): 1, 25, 26.
(E1=1, C1=2, A1=3, E2=4, etc.): 3, 26, 27.
(A10=1, C10=2, E10=3, A9=4, etc.): 4, 5, 28.
(E10=1, C10=2, A10=3, E9=4, etc.): 5, 6, 30.

Counted alternatingly (from front and back):
(A1=1, C1=2, E1=3, E2=4, C2=5, etc.): 1, 25, 26.
(E1=1, C1=2, A1=3, A2=4, C2=5, etc.): 3, 26, 27.
(A10=1, C10=2, E10=3, E9=4, C9=5, etc.): 5, 6, 30.
(E10=1, C10=2, A10=3, A9=4, C9=5, etc.): 4, 5, 28.

So there are only four different ways of localizing the empty fields here.

Counted in columns:
(A1=1, A2=2 ... A10=10, C1=11, C2=12, etc.): 1, 9, 19.
(E1=1, E2=2 ... E10=10, C1=11, C2=12, etc.): 19, 21, 29.
(A10=1, A9=2 ... A1=10, C10=11, C9=12, etc.): 2, 10, 12.
(E10=1, E9=2 ... E1=10, C10=11, C9=12, etc.): 12, 22, 30.

Counted alternatingly (from front and back):
(A1=1, A2=2 ... A10=10, C10=11, C9=12, etc.): 1, 9, 12.
(E1=1, E2=2 ... E10=10, C10=11, C9=12, etc.): 12, 21, 29.
(A10=1, A9=2 ... A1=10, C1=11, C2=12, etc.): 2, 10, 19.
(E10=1, E9=2 ... E1=10, C1=11, C2=12, etc.): 19, 22, 30.

So only the following fields of the table are empty, in each case only in the specified combination:

1,2,3,4,5,6,9,10,12,19,21,22,25,26,27,28,29,30, a total of 18 possible positions. It lacks 7,8,11,13,14,15,16,17,18,20,23,24, i.e. twelve fields are excluded. Interestingly, there are only in 12 fields horizontal lines as entries.

6 Number Crunching

The 27 labeled fields in the table suggest that it might be a (sidereal) lunar calendar. We can play around with the numbers to see if there are known numbers or numerical ratios that correlate with astronomical or palaeo-astronomical data.

Let's look at our matrix and construct component-by-column and row sums::

Row \ Column	A	C	E	Row total
1	0,0	4, 0	2,0	6, 0
2	2,0	3, 0	3,0	8, 0
3	2,0	4,10	3,0	9, 10
4	2,0	3, 3	3,0	8, 3
5	2,0	3, 3	4,8	9, 11
6	2,0	3, 7	4,6	9, 13
7	2,0	3,12	4,8	9, 20
8	2,0	3,10	4,5	9, 15
9	0,0	0, 0	4,3	4, 3
10	3,0	3,10	5,0	11,10
Column sum	17,0	29,55	36,30	82,85

Let's use the numbers to discover known numerical ratios under the assumption of a lunar calendar. First some facts:
A sidereal month has about 27.321661 days.
A synodic month (Lunation) has about 29.52986111 days.

We must not expect that the people of the Karanovoculture carried out great bills, nor did they control the fractional bill like the ancient Egyptians, or even use a decade-decimal system. Nonetheless, we use our modern way of computing to find implicit relationships that implicitly result from simply counting astronomical or other physical phenomena within a cyclic system.

So we form relationships:

$$\frac{27.321661}{29.52986111} = 0.9252214...$$

An approximation is

$$\frac{27.3}{29.5} = 0.9254237...$$

A somewhat rough approximation provides

$$\frac{27.5}{29.5} = 0.9322033...$$

Roughly calculated, the result is still around 0.93:

$$\frac{27}{29} = 0.931034482...$$

Counted in half-days, 27.5 days correspond to 55 half-days and 29.5 days to 59 half-days.

$$\frac{27.5}{29.5} = \frac{275}{295} = \frac{55}{59} \approx 0.93$$

There is also $\frac{55}{59} = \frac{55}{29+30}$ where many numbers appear from our sums. 27, 29, 30, 55 are numbers we got from the Karanovo table.

The Saros cycle of the eclipses, the time until the full moon again stands before exactly the same fixed star, is about 18.03 years = 223 synodic months (lunations) = 6585.159 days $\approx$ 241 (more precisely: 241.023377) sidereal months.

$$\frac{223}{241} = 0.925311203 \approx 0.93$$

Difference between the two monthly numbers: $241 - 223 = 18$, which corresponds to the cycle duration in years.

The 6585 days of the Saros cycle correspond to about $227 * 29 = 6583 \approx 244 * 27 = 6588$.

The difference is

$$6588 - 6583 = 5 \text{ days}$$

$$\frac{227}{244} = 0.930327868... \approx 0.93$$

and

$$244 - 227 = 17$$

another number from our fundus!

In antiquity, the Tri-Eteris was used as a subcycle of the saros cycle to synchronize three seasons and lunar years in synodic and sidereal lunar months:

$$3 \cdot 365 = 1095 \approx 1092 = 40 \cdot 27.3 \approx 37 \cdot 29.5$$

With the numbers from the Karanovo table:

$$36 \cdot 30 + 17 = 1097 \approx 1095 \text{ days of Tri-Eteris}$$

$$1097 \cdot 6 = 6582 \approx 6585 \text{ days of the Saros cycle}$$

$$6585 - 6582 = 5 \text{ days difference}$$

We can still calculate further:

$$56 = 55 + 1 = 27 + 29$$

$$29 \cdot 55 = 1595$$

$$(17 + 36) \cdot 30 = 1590$$

$$1595 - 1590 = 5 \text{ days surplus of Tri-Eteris (as above: 1097-1092)}$$

and

$$(1595 + 17) \cdot 4 = 6448 = 17 + 29 + 55 + 36 = 137 = 167 - 30 = (82 + 85) - 30$$

One solar year lasts (rounded) 365 days. One lunar year $12 \cdot 29.5$ days = 354 days. The difference is 11 days. With [3] we ask: "How long do you have to wait for the lunar year to start again in the same month? To solve this question, one has to calculate how often 11 days difference to fill a lunar year of 354 days. This is 32 solar years, each with 11 days difference, because $32 \cdot 11 = 352$. After 32 solar years you have 352 days offset, which corresponds to almost a lunar year. The mistake is only 2 days. In other words, 32 solar years equals 33 lunar years. "

$$\frac{32}{33} = 0.96969696... \approx 0.97$$

This year's expectation can be found on the Sky Disc of Nebra.

Again we find

$$\tfrac{82}{85} = 0.964705882..., \text{ very roughly rounded } 0.97.$$

$82 \cdot 365.25 = 29950.5$, $85 \cdot 29.5 * 12 = 30090$ which corresponds to approx. 822 years, with only 140 days errors. So, these figures could possibly reflect the annual expectation of the Karanovo table.

Then we still find

$$6585 - 6448 = 137 \approx 140, \text{ what a coincidence!}$$

Now it can be argued that such number games do not prove anything, since one can, depending on the permitted inaccuracy, calculate any number. That is perfectly right and thus the conclusions are also to be considered with the necessary skepticism. We could also calculate π or e or h with the given numbers with the appropriate effort ... [You do not believe that? Look into the appendix!]

However, the conclusion to be suggested is that the Karanovo table could indeed be a Lunar solar calendar that implicitly includes cyclical events such as lunar eclipses, years, synodic and sidereal lunar cycles, and possibly even the saros cycle. Even if this assumption is true, we can not say anything about the real use of the table.

Unfortunately, the author is not so much concerned with astronomy or even palaeo astronomy that the numbers could give him more clues. That would be a task for the relevant professionals.

Further numerical calculation gives the following tables:

Component-wise addition:: a,b -> a+b

Row \ Column	A	C	E	Row total
1	0	4	2	6
2	2	3	3	8
3	2	14	3	19
4	2	6	3	11
5	2	6	12	20
6	2	10	10	22
7	2	15	12	29
8	2	13	9	24
9	0	0	7	7
10	3	13	5	21
Column sum	17	84	66	167 = 82+85 = 2x83.5

Component-wise multiplication: a,b -> a*b

Row \ Column	A	C	E	Row total
1	0	0	0	0
2	0	0	0	0
3	0	40	0	40
4	0	9	0	9
5	0	9	32	41
6	0	21	24	45
7	0	36	32	68
8	0	30	20	50
9	0	0	12	12
10	0	30	0	30
Column sum	0	175	120	295

Component subtraction: a,b -> a-b

Row \ Column	A	C	E	Row total
1	0	4	2	6
2	2	3	3	8
3	2	-6	3	-1
4	2	0	3	5
5	2	0	-4	-2
6	2	-4	-2	-4
7	2	-9	-4	-11
8	2	-7	-1	-6
9	0	0	1	1
10	3	-7	5	1
Column sum	17	-26	6	-3

7 Appendix

What else is hidden in the numbers of the Karanovo calendar? Take, for example, The following four numbers that we found when counting the Karanovo calendar:

- A = 27
- B = 29
- C = 30
- D = 55

The calculation

$$\frac{B^2 D^2}{C^4} = 3.141$$

is approaching π with the amazing accuracy of an error below *0.001*!

The calculation

$$\frac{A^3 \cdot D^2}{B^3 \cdot C^2} = 2.713 \approx e = 2.718$$

provides a good approximation to Euler's number with an absolute error of only *0.005* .

Then we still have the Planck effect quantum $h = 6.626 \cdot 10^{-34}$. What do we find when we do the following?

$$\frac{B \cdot D^3}{A \cdot C^3} = 6.618$$

Planck's effect quantum, better than Max Planck himself determined it at the beginning! (I simply omitted the powers of ten for the sake of simplicity ...)

So did the old Europeans already have such a good knowledge of mathematics and quantum physics?

Answer: No, of course not, these number games are completely meaningless! It is easily possible to arbitrarily approximate any number with any other numbers. Only the formula effort increases [4].

8 Sources

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