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# ARE THERE 12 OR 10 THE MINOAN SOLAR 'MONTHS'? A REASSESSMENT

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## ABSTRACT

Sir A. Evans the founder of prehistoric archaeology excavated in Knossos, Minoan Crete, but he did not cover the calendric aspect of the Minoan Civilization 2600-1100 BC. He unearthed artifacts which could have been interpreted as calendars but he considered them as board games played under unknown rules. Archaeoastronomers have tried to solve the calendric Minoan problem, and through the orientation of the sun they have found the time of the two solstices and the two equinoxes. Based on these, they have tried to build up a Minoan twelve-month solar calendar. Probably they were preoccupied by the knowledge of the Egyptian twelve-month solar calendar of 30 days each and therefore they thought that the Minoans followed the Egyptian prototype. However, this was not the case. The principle of orientation was easy to be found and understood by the 20th century archaeoastronomers but for the farmers, shepherds, and fishermen of the Minoan age it was extremely difficult to understand. The expert authorities (priesthood) of the Minoan people, observed the orbit of the moon and the sun, and they invented a kind of calendars. The division of 365 days in smaller manageable periods of time was pictured on earthy materials, ceramics, or flat stones, named the kernoï. Thus, it was easy for any Minoan to make a solar calendar. The professional guilds were most benefitted. From 165 stone pieces of kernoï the 73 well preserved Minoan flat kernoï some of those are decodes as solar calendars.

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**Keywords:** Archeoastronomy, Minoan astronomy, calendars, Minoan solar calendars, kernoï

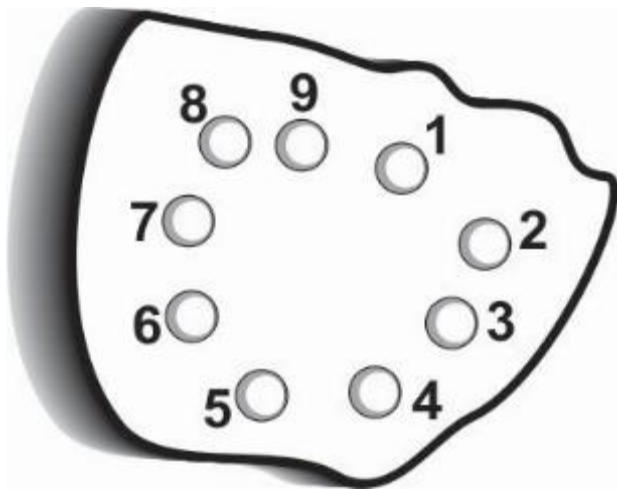
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## 1. INTRODUCTION

The origin of ancient calendars has been a hot issue of global research. (Parker 1950; Richards 1999; Steele 2007; Stern 2012; Castro 2015; Hannah 2015)

The connection of human observation, wonder and curiosity with the skyscape and periodical phenomena of celestial bodies has been the inseparable link since prehistoric times. In the present paper a reassessment of the hitherto thought origin to ancient cultures along the Middle East - Near East and South Eastern Mediterranean axis, is made confirming a 3<sup>rd</sup> millennium BC Aegean knowledge of Minoan culture, and transmitted to later aegean cultures (Liritzis et al., 2017; Liritzis & Castro 2013; Liritzis & Vassiliou 2003, 2006).

To present this paper, it is necessary to define the key terms of what a calendar and a kernos are: a) A calendar is a system for managing the time, whereby the beginning, the length and the division of time are fixed, and days as well as longer divisions of time are arranged in a definite order, Herberger (1983). b) A kernos is a pottery ring or stone tray in which several cups for holding offerings are carved (Whittaker, 2005; Cucuzza, 2010) (Fig. 1).



*Figure 1. A model of a kernos from Kommos with nine cups for counting nine time periods (made by the author based on photos of the object by Whittaker 2005, 2005).*

There are at least three archaeoastronomers or archaeologists who have made two proposals through their studies of the orientation of the sun on several peak sanctuaries, Palaces, or temples, that the Minoans used. Was it possible for a Minoan farmer, shepherd, or fisherman of the first quarter of the second

millennia BCE to be able to understand the above orientations of the sun and to base their seasonal work on something that they did not totally know? No, it was not possible. It is reminded that those orientations have been observed, measured, and published by Henriksson & Blomberg (2011) and Ridderstad (2020), who end up with the following two proposals.

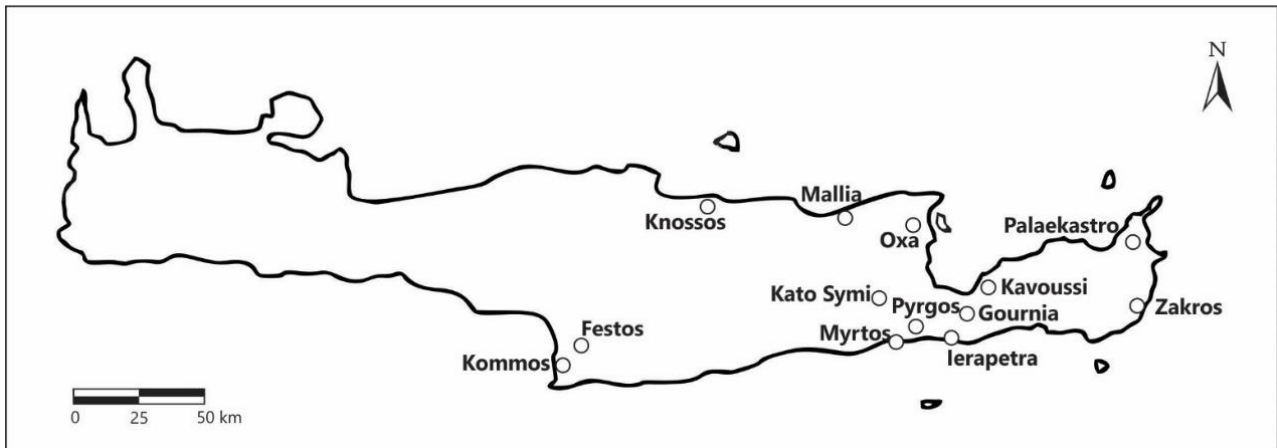
1) Henriksson and Blomberg's (2011): "Later results at three other Minoan sites underscored the probability that the Minoans had a solar 12-month calendar."

2) Ridderstad's (2020): "The central courts of Knossos and Phaistos were oriented to the sunrise of five days before the spring equinox or after the autumn equinox". ... "The date was related to a Minoan festival celebrated on the five added days at the end of the solar year. The model for this kind of solar calendar probably came from Egypt."

In this paper it will be proven that there were two types of Minoan solar calendars, which were totally different from the Egyptian one, having 12 months of 30 days each, plus the 5 'epagomenae' days added to the end of the 360 days, Claggett (1995). [NB: Epagomenal days for Egypt are days within a solar calendar that are outside any regular year which were added by priests. For Minoan Epagomenae <Greek verb επιγράφω>, i.e., those days had better not exist, due to a prehistoric taboo (Fraser, 2002) (in earlier works we reported on the lunar and lunisolar aspect of the Minoan flat kernoi, Pliakos 2015, 2019)].

Those two types of Minoan calendars were carved on flat stone kernoi with the suitable number of cups. The first type counted 10 Minoan solar 'months' of 36 days each and the second one counted 40 'weeks' of 9 days each. In both calendars - the Egyptian - 5 'epagomenae' days were split into 3 days at the beginning and 2 days in the middle of the year of 365 days.

However, Henriksson, Blomberg and Ridderstad have not taken into consideration the large number of kernoi found by 22 archaeologists in 16 different places in Minoan Crete, Hillbom (2005) (Map 1). It will be proved that kernoi bearing suitable number of cups were used as calendars, if there was a corresponding calendrical meaning (Pliakos 2015b, 2019). Worth mentioning, Downey (2015) has proposed another use of Kernoi as magnetic compass and eclipse predictors. The present study complements earlier reports on the two kinds of solar Minoan calendars by adding eight more kernoi artifacts, and verifies earlier arguments concerning the Minoan calendar.



Map 1. Crete in the Aegean Sea. Sites where some kernoi of the present study were unearthed.

## 2. METHODOLOGY & INTERPRETATION

### 2.1 The First type of Minoan solar calendar: counting 10 solar 'months' from 8 kernoi

#### 2.1.1 A half-kernos unearthed at Knossos, dated MM II (Evans, 1930)

The half of the kernos unearthed by Sir A. Evans in 1904 (published in 1930) at the Megaron of the Queen, Knossos, Fig. 2, was completed by him. In that publication Evans characterized the use of this kernos as a game-board, where games were played but he did not produce any rules. For proving my argument that the Minoans used a solar calendar distributing the 365 days in 'months' differently from the Egyptians, I will decode the completed by Evans kernos - finally 46 cm x 46 cm - as a Minoan one-year solar calendar.

A straightforward decoding can be easily made from Fig. 2, if the researcher reminds that the Egyptians had 5 'epagomenae' days added to the end of 360 days, Claggett (1995); then, the diagonally carved 3 and 2 joint cups sum up to 5 places for the calendar-tender to mark those 5 (=3+2) days. The 8 (=4+4) similar cups and the 2 (=1+1), i.e the 2 equinoxes, similar

but bigger cups in the perimeter are places for the calendar-tender to mark 10 units of some unknown period, probably months. Therefore, the distribution of 360 days (=365-5) into 10 cups (=8+2) means that each one of the 10 periods counts 36 days per cup (=360:10). The beginning of a Minoan solar year is on the autumn equinox, e.g., the 22<sup>nd</sup> September, for practical reasons, Henriksson and Blomberg (2011) [NB: The dates of the two equinoxes and the two solstices appear in Fig. 2]. Next to the 10 cups the dates counted in each cup are written (see, Fig. 2).

Needless to argue that it cannot have been easy for a calendar-tender to mark the days of a 36-day solar 'month' calendar using 36 pawns because the cups were too small; the (4+4) + (1+1) cups of the Evans' kernos have a diameter of 5.5 - 6.0 cm and depth of about 1.5 - 2.0 cm. Therefore, the researcher will try to find a kernos with 36 cups or with 4 similar in size cups x 9 bigger ones (4X9=36), Figure 6. The 36 days can be marked (a) in 18 similar cups + 1 bigger cup, counting the first or the second 18-day period, (18X2=36), Figure 7; (b) in 9 similar cups + 1 bigger cup, counting the first, the second, the third or the fourth 9-day period, (9X4=36), Figure 8; (c) in 9 cups (4 pawns per cup), Fig. 9.

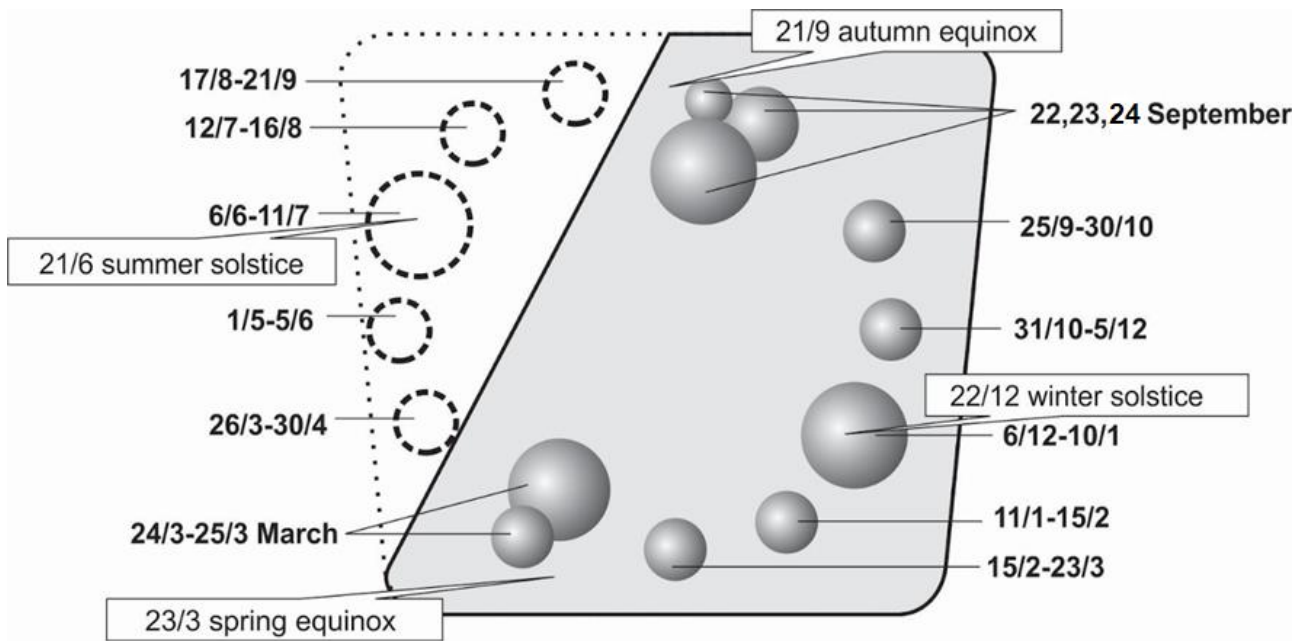


Figure 2. Part of original Kernos found by Evans (1930). The gray part is the found piece and white is the complementary part by Evans too. The circles are cups, some partially superimposed. The dashed cups were added by Evans on a symmetrical pattern with respect to the original gray pattern. The numbers are our own. The 23/3 and 21/9 points to the expected location.

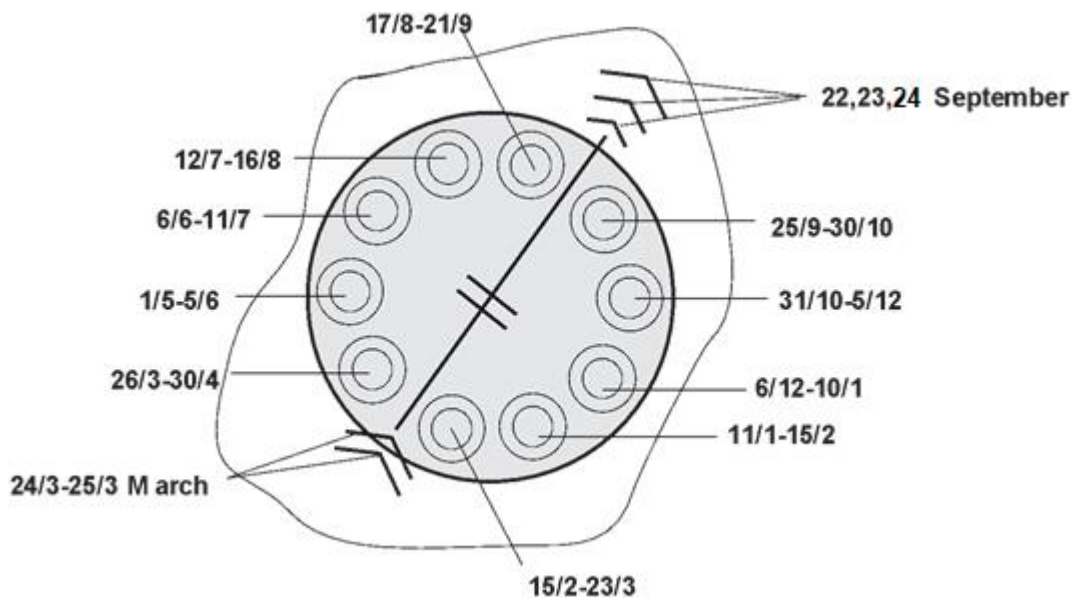


Figure 3. Part of original Kernos found by Boyd (1901, Fig.7). The cups represent Minoan months. The numbers are our own. The 2 segments in the middle of the solid diameter point to line the 2 solstices; the 2 badly preserved obtuse angles for the 24<sup>th</sup> and the 25<sup>th</sup> of March and the 3 upper right obtuse angles are for the 22<sup>nd</sup> to 25<sup>th</sup> of September (drawn by the author based on photo by Boyd 1901).

### 2.1.2 A kernos unearthed at Kavoussi, undated: Boyd (1901)

It is easy for anyone to find the same characteristics in kernos Fig. 3 as in Fig. 2. Boyd characterized it as a 'game-board', but she did not produce any rules for playing it.

### 2.1.3 An undated kernos unearthed at Knossos (Warren 1984)

It is easy for anyone to find in kernos Figure 4 the same characteristics as in Figs. 2 and 3. Warren characterized it as a 'libation table' [A libation table or vase is a ritual dish pouring of a liquid, or grains, as an offering to a deity].

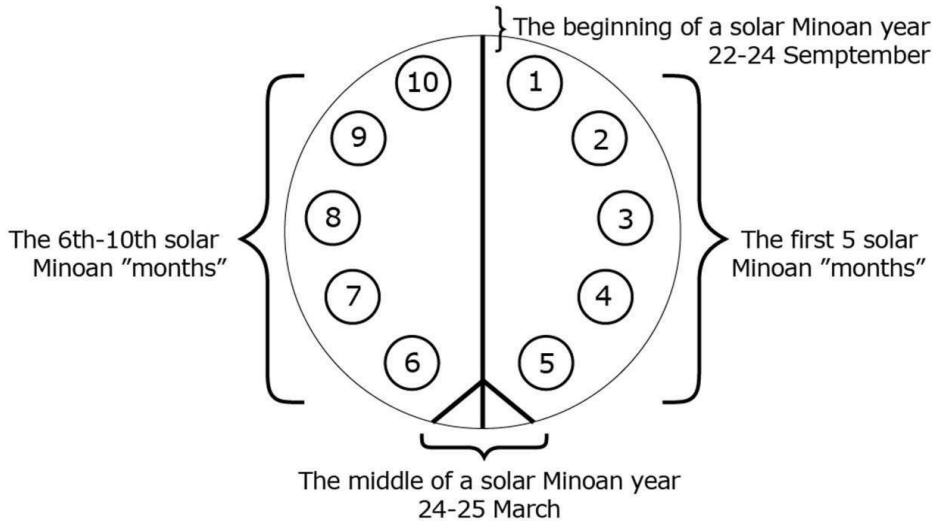


Figure 4. Badly preserved Kernos drawn by the author based on photo by Warren 1984).

**2.1.4 A kernos found at Mt. Oxa rooted in the soil, undated (Hood 1995).**

It is easy for anyone to find in kernos Fig. 5, the same characteristics as in Figs. 2,3 and 4. The archaeologist H. Van Effenterre (1955) wrote that during the excavation at mountain Oxa, at Lassithi, he observed a kernos on a rocky surface. This kernos was divided into two halves (5+5 cups) by a diameter AB of 22 cm. The photo presented in the article of Hood 'Minoan cup-marks' was not clear enough. Thus, the author tried to bridge the gap. The engravement was carved on a rooted rock having remained in the open air for thousands of years, model Fig. 5. Therefore, it has been badly preserved. Nevertheless, the grey colored zone is forming a channel, probably for the rain to flow through. The calendar tender placed the 3 and the 2 pawns for counting the 'epagomenae' days in the adjoint cup C. The points A and B signify the beginning and the middle of a solar year.

**2.1.5 A kernos unearthed at Knossos, undated (Hood 1995)**

The researcher is obliged to search for a kernos or artifact to advance the documentation, proving that the Minoan one-year solar calendar is composed of 10 solar 'months' of 36-day each. The archaeologist Hood (1995) excavated at Knossos where he found a ruined kernos of 120 cm x 120 cm, 5 m. away from the Queen's Megaron region, where kernos in Fig. 2 was

unearthed, Hillbom (2005). It bore nine big cups and four small ones, Fig. 6. The multiplication of those number of cups 4X9 results in 36 places where 36 days can be marked; thus, a calendar-tender could mark 4 periods of 9 days each easily now. Every new 'week' and every new day were marked with a pawn. Thus, the 36 day-period is called one solar 'month', and the 9 day-period a solar 'week'. It is evident that one 'month' consists of 4 nine-day 'weeks'. The marking on the calendar in Fig. 6, dates: The fifth day of the fourth 'week' is running, i.e., the 32nd day (= 3X9+5) of one solar 'month'.

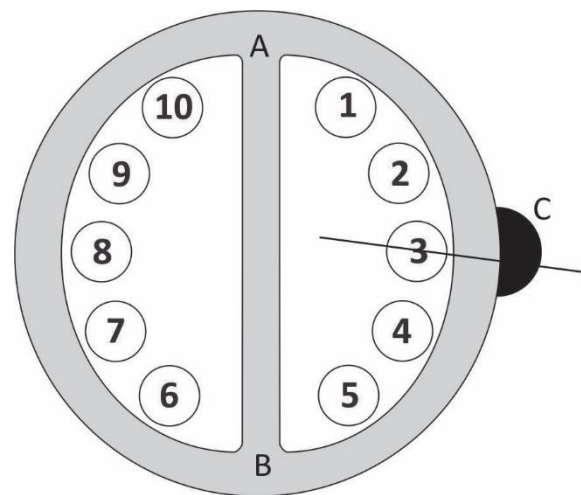


Figure 5. Badly preserved Kernos on a rock (rock art like) drawn by the author based on photo by Hood (1974).

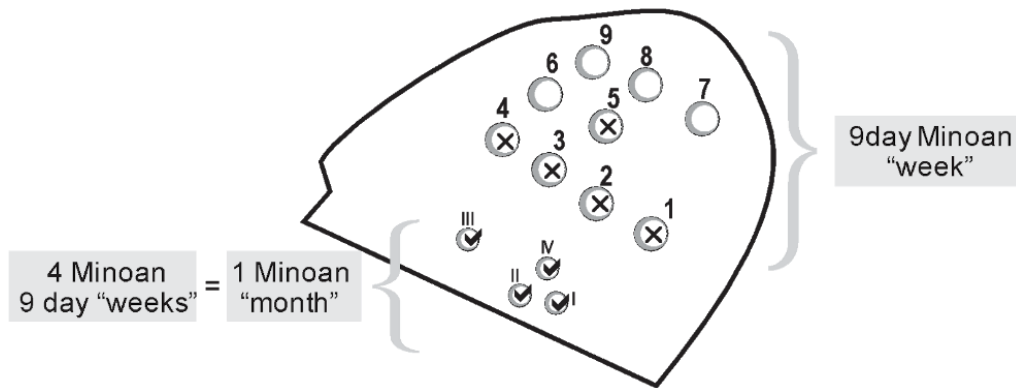


Figure 6. Piece of Kernos drawn by the author based on photo by Hood (1995).

### 2.1.6 A kernos unearthed at Gournia, dated from MM I (Soles 1979)

This kernos was unearthed at Gournia by Soles (1979), who dated it to about Middle Minoan I; its dimensions are 36 cm x 11 cm, Fig. 7. There are 18 similar cups and 1 bigger one. At the beginning of the first and the second 18-day period the calendar tender placed the first and the second pawns in the bigger cup. At the beginning of every new day 1 pawn is placed in each of the 18 similar cups. H. van Effenterre (1955) unearthed two kernoi - probably of the same type - one at Mallia and one at Gournia. The marking of the calendar in Fig. 7, dates: The fifth day of the second 18-day-period is running, i.e., the 23rd day (=18+5) of one Minoan solar 'month'.

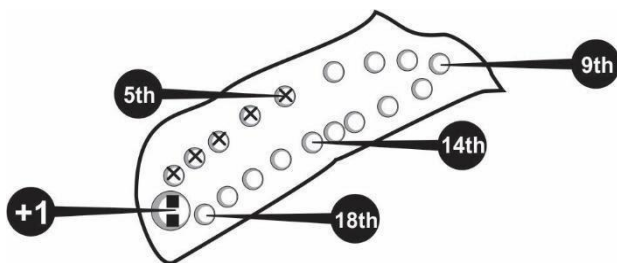


Figure 7. Drawn Kernos from Gournia, based on photo by Soles (1973).

### 2.1.7 A kernos unearthed at Kommos (in Phaistos), undated. Drawn from photo by Whittaker (1996)

This kernos was unearthed by Whittaker (1996) at Kommos, Phaistos and it was undated; its dimensions are 29 cm x 28 cm, and it looks like a pentagon, Fig. 8. At the beginning of the first, second, third and fourth 9-day period the calendar tender placed one, two, three and four pawns, one after the other, in the big cup (+1). Each new day was marked in the 9 similar cups with 1 pawn. Another kernos of the same type was unearthed at Gournia by Soles (1973). The marking of the calendar in Figure 8, dates: The fourth day of the third "week" is running, i.e., the 22nd day (=2X9+4) of one Minoan solar "month".

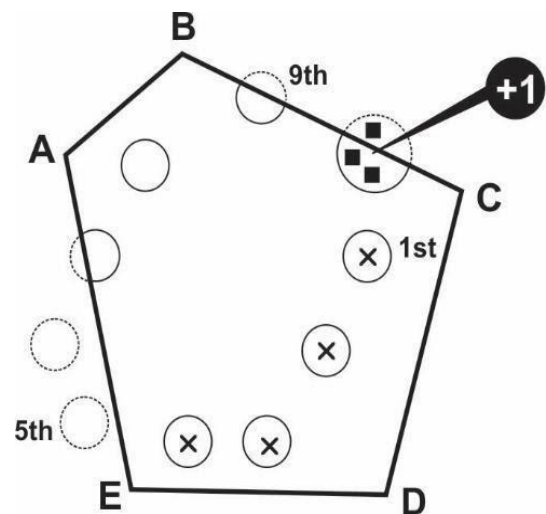


Figure 8. Drawn Kernos from original photo by Whittaker (1996).

### 2.1.8. A kernos unearthed at Kommos, dated MM IB - MM II (Whittaker 1996)

The kernos in Fig. 1, was unearthed at Kommos by Whittaker (1996, 321-323, no. 5, table 4.53), who made excavations at Kommos, Phaistos, central hill, area 17, where she found a kernos of 22 cm X 18 cm, with 9 cups, stone no. 91, Heraklion Museum, dated back to MM IB - MM II periods. Each day of the 9-day week is marked with pawns in the 9 cups. If the capacity of the cups is 4 pawns per cup, then the four 36-day weeks of a Minoan solar month (= 4 X 9) can be counted on it. Another kernos of the same type was unearthed by Whittaker (1996) at Kommos, Phaistos.

## 3. THE SECOND TYPE OF ONE-YEAR MI-NOAN SOLAR CALENDAR COUNTING 40 'WEEKS': 4 KERNOI

Since the Minoans used a 9-day week, the researcher is obliged to see if there was a second type of a one-year solar calendar on a kernos counting the 40 or twice the 20 (=10+10) solar weeks. A possible configuration for such a kernos/kernoi would be: (a) 40 or 2X20 or 2X (10+10) similar cups for counting the 40

'weeks' of the 360-day (=40x9) period, (b) 1 big cup for counting the 3 + the 2 'epagomenae' days at the beginning as well as in the middle of the year correspondingly.

**3.1 A Kernos of 41 cups from Mallia, of LM I**

Chapouthier (1928) unearthed an almost six-sided broken kernos at Mallia (Fig. 10), supposing it was a libation table which is a ceramic or flat stone table on which liquid offerings or earthy products are poured at religious sites (Warren, 1984). This kernos was partly reconstructed using at least three of its broken parts. The reconstructor connected the parts ignoring what the function of the 39 similar cups was. Therefore, he missed to include one cup at the edge of two broken parts, (just before the 37th cup, the blank cup in Fig. 10). Thus, the total number of cups are now forty plus a bigger one (40+1) on the right in which 3 out of the 5 'epagomenae' days are counted at the beginning of the solar year.

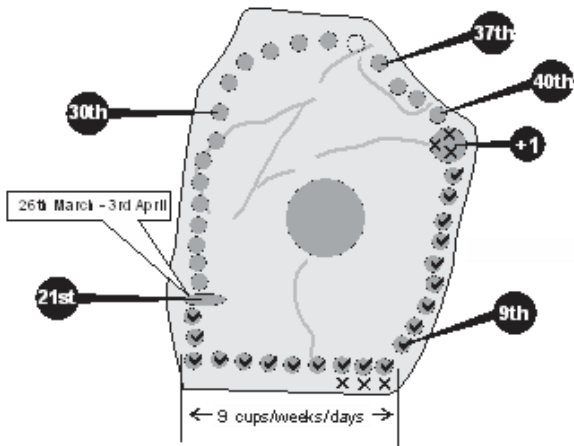


Figure 10. Drawn Kernos by the author based on a photo by Chapouthier (1928).

The 21st cup is of an oval shape, not a circle, notifying to the calendar tender to count the two 'epagomenae' days, the 24th and on the 25th of March before starting counting the 1-9 days of the 21st cycle of a new Minoan solar week. The biggest central cup is for keeping the pawns to be used, Van Effenterre (1955). The interpretation of the function of the above-mentioned kernos as a 'one-year Minoan solar calendar' appears in the solved exercise below (see inset).

**Exercise:** Suppose that there are: a) three days' pawns (3 X's) in the big cup (+1); b) twenty 9-day-week pawns (20 V's) in the first 20 similar cups; c) three day's pawns (3 x's) in the 9 horizontal cups. What is the date in this Minoan solar year?

**Solution:** a) The three-day pawns in the big cup (+1) denote that the 22nd, the 23rd and the 24th September, i.e., the three 'epagomenae' days at the beginning of the

year have passed; b) The twenty 9-day-week pawns denote that 19 weeks have passed, i.e., the 171st day has passed (19X9=171); c) The three-day pawns on the horizontal line denote that the 3rd day of the 20th week is running. Therefore, the current day of the year is the 17th March (171+3 days) of our calendar.

**3.2 A kernos with 40 cups unearthed at Mallia, undated**

Dessenne (1952, Fig.90) unearthed a large round kernos at Mallia, Figure 11. Its diameter is 100 cm, with a large central cup (diameter 18 cm and depth 7 cm) for keeping the pawns; on its perimeter there are 37-40 cups (diameter 5-6 cm and depth 1 cm). The number of cups was estimated by the excavator Dessenne. The +1 cup is larger (diameter 9 cm) for the calendar tender to mark the 3 + 2 'epagomenae' days.

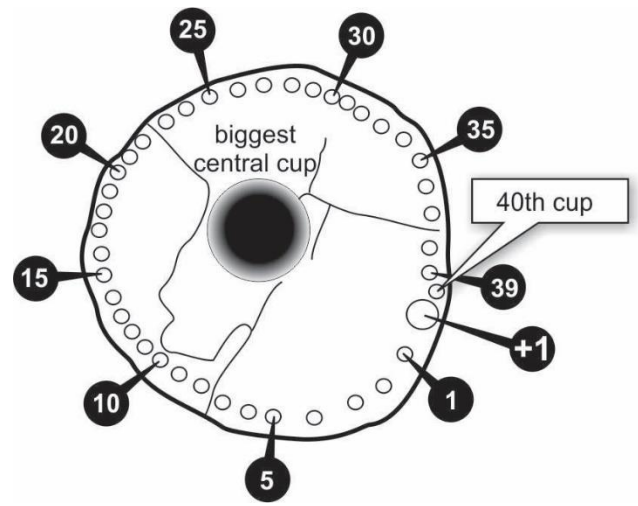


Figure 11. Piece of Kernos drawn by the author based on photo by Dessenne (1952).

**3.3 A kernos with 40 cups unearthed at Mallia, dated to MM I.**

H. & M. Van Effenterre (1976) have unearthed a rectangular kernos at Mallia. Its surface dimensions are 52 cm x 43 cm and one of its corners is broken (Fig. 12). The kernos bears 39 cups (diameter 2,5 - 3 cm), plus 1 bigger cup (+1) in the upper right corner (diameter 5 cm); There must have been 1 more cup in the broken/missing lower left corner. The 40 cups are distributed on the four sides of the kernos as follows: on the big cup in the upper right corner the calendar tender marks the 3 days at the beginning and the 2 'epagomenae' days in the middle of a solar year. The right vertical line has 8 cups; the low horizontal line has 12 cups; the left vertical line has 9 cups, and the up horizontal line has 11 cups. The 40 cups on the kernos count the forty weeks of a 360-day period plus the (3+2) 'epagomenae' days make the 365 days of a solar year.

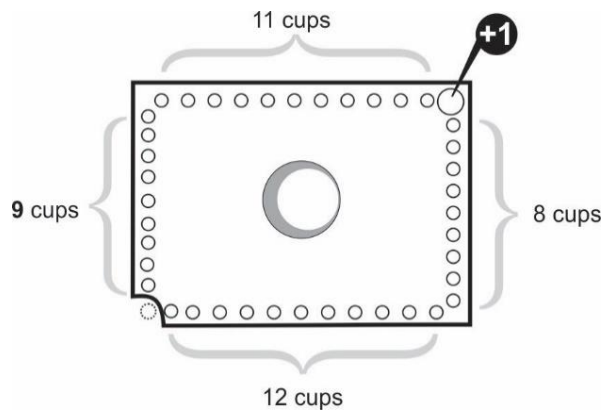


Figure 12. Piece of Kernos drawn by the author based on photo by H. & M. Van Effenterre (1976).

### 3.4 A kernos of 40 cups counting 40 weeks (Kommos, undated, Fig.13).

Whittaker (1996) unearthed a reused rectangular kernos at Kommos, Phaistos, building T. Its surface dimensions are 82 cm X 68 cm. It has 10+10 cups on it forming an oval shape (18 cm x 30cm) + one similar cup outside the shape (upper right side), Figure 13; the 10 + 10 + 1 cups are very shallow, 1-1.5 cm in diameter. There is also a central big cup as well as an equally big, grey cup, outside the oval shape, 3-4 cm

in diameter. The three 'epagomenae' initial days of a Minoan solar year, (22<sup>nd</sup>, 23<sup>rd</sup> and 24<sup>th</sup> September), are marked in the upper right-side cup with three pawns. On each day of the nine days of the 1<sup>st</sup> week the calendar tender places one pawn in the grey cup. At the end of each 'week' the 9 pawns are removed to be reused for the new 'week'. The first 9-day 'week' of the year is marked in the 1<sup>st</sup> of the 10 similar cups (named A) on the low left-side of kernos. The 2<sup>nd</sup> 'week' is marked in the 2<sup>nd</sup> of the 10 similar cups and so on till the end of the 10<sup>th</sup> week, which must denote the end of autumn. The same process is followed for the next 10 cups (11<sup>th</sup> - 20<sup>th</sup>) 'the winter 'weeks'' by placing pawns in the second group of the similar 10 cups of the kernos. At the end of the 20<sup>th</sup> 'week', which denotes the end of winter, the two 'epagomenae' days (24<sup>th</sup> and 25<sup>th</sup> March) are marked in the upper right-side cup. The same process follows for the 10 spring 'weeks' (21<sup>st</sup> - 30<sup>th</sup>) as well as for the 10 summer 'weeks' (31<sup>st</sup> - 40<sup>th</sup>). The last day of the 40<sup>th</sup> week is the 21<sup>st</sup> September; the next day is the 22<sup>nd</sup> September, which is the first day of a new year. The central big cup is a depot, H. Van Effenterre (1955, 1976), for the pawns to be used.

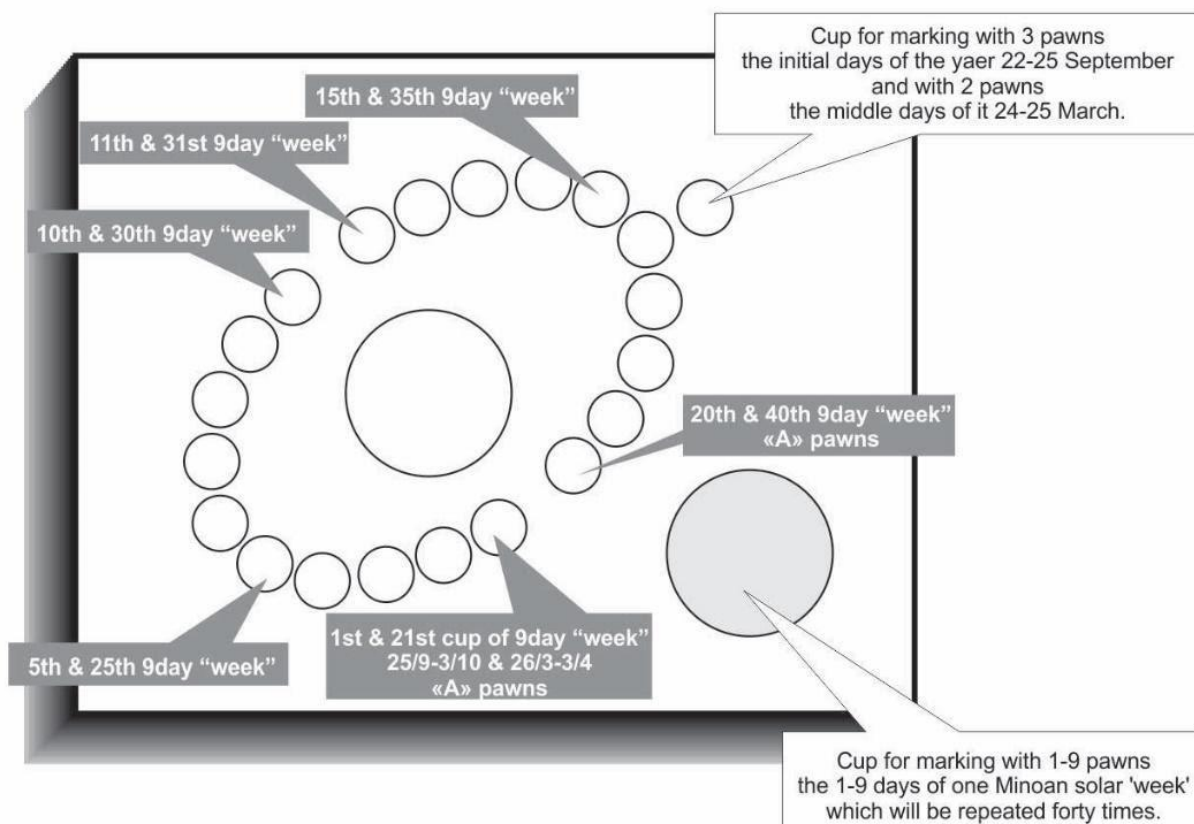


Figure 13. Kernos drawn by the author based on photo by Whittaker (1996).



#### 4. CONCLUSION

The question of what the Minoan kernoi were used for, has been tantalizing the old and the new archaeology (now a multidiscipline science) since the beginning of the 20th century. Famous archaeologists gave two answers. They either were: (a) boards for playing (unspecified) games, as Evans (1930), Boyd (1901), Van Effenterre (1955) and others supported, or (b) libation tables, as Chapouthier (1928), Demargne (1932), Warren (1972) and others supported. None of them proved these arguments as they did not think of combining the observed frequency of the number of cups on kernoi with the knowledge of prehistoric Egyptian solar calendar.

Having studied the Minoan kernoi for several years I have concluded that the Minoan flat kernoi were either lunar, lunisolar or solar calendars, or parts of them, if a corresponding calendric configuration exists. The distribution of 365 days of one Minoan

solar year is as follows either: (a) 3 celebration or ritual days at the beginning of a new year (22<sup>nd</sup>, 23<sup>rd</sup> and 24<sup>th</sup> September) + 20 Minoan solar 9-day 'weeks' + 2 celebration or ritual days in the middle of the year (24<sup>th</sup> and 25<sup>th</sup> March) + 20 Minoan solar 9-day 'weeks', or (b) 3 celebration or ritual days at the beginning of a new year (22<sup>nd</sup>, 23<sup>rd</sup> and 24<sup>th</sup> September) + 5 Minoan solar months of 36 days each + 2 celebration or ritual days in the middle of the year (24<sup>th</sup> and 25<sup>th</sup> March) + 5 Minoan solar months of 36 days each. This distribution of 365 days has nothing to do with the Egyptian distribution of 365 days, which consists of 12 solar months X 30 days each + 5 'epagomenae' days added to the end of the 360 days. Therefore, the proposal of Henriksson & Blomberg (2011) and Ridderstad (2020) that a Minoan one-year solar calendar has derived from the corresponding Egyptian one should be reconsidered.

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