

Calendars of the Dead-Sea-Scroll Sect *

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*"Faithful is God in His words and gracious in all His deeds."
Dead Sea Scrolls: (Ashrei) Psalm 145 [T4], [BR], [DA] ¹*

ABSTRACT.

The Dead Sea Scrolls was the name given the documents first discovered by Bedouins in 1946 in several caves in the Qumran area, southeast of Jerusalem [SL:29-30]. They were believed to have been written by Jews called the Essenes from about 250BCE to 70CE. They were held mostly by Jordanians in east Jerusalem until the Six-Day War in 1967 and then by Israelis. However, the same group of scholars were examining them closely and it was not until the 1990s that they were open to all scholars. Nevertheless, a number of articles and books on the Dead Sea Scrolls were produced in the last fifty years—especially in the last decade. In these publications, there are a number of descriptions of what the Essenes used as calendars—especially the intercalated $[52 \times 7]$ 364-day solar one and the lunar $[6 \times (29, 30)]$ 354-day one. We try to explain the details of these.

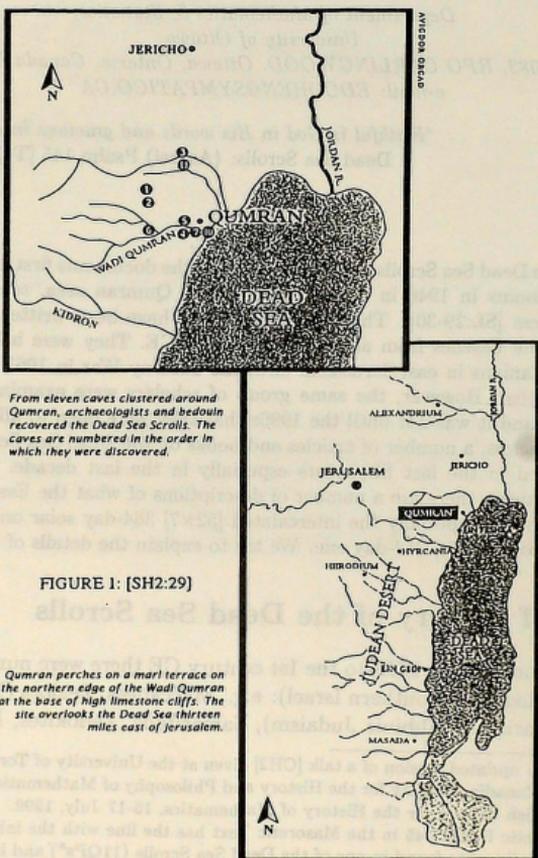
1 Brief History of the Dead Sea Scrolls

From the 2nd century BCE to the 1st century CE there were numerous Jewish sects in Judæa (now southern Israel): e.g., Maccabees, Zealots (Masada), Sadducees, Pharisees (rabbinic Judaism), Samaritans, Zadokites, Essenes, early

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¹The acrostic Psalm 145 in the Masoretic Text has the line with the initial letter "nun" omitted. This line was found in one of the Dead Sea Scrolls (11QPs^a) and is translated here [T4:570-571], [BR:150].

(Jewish) Christians. This was a period of great historical importance: it encompassed the Maccabean revolt against Syria in the 2nd ce. BCE, the rule of King Herod I (also known as "the Great") from 40BCE - 4BCE, the birth of Jesus ca. 4BCE, the destruction of the Second Temple by the Romans in 70CE, the destruction of Masada by the Romans in 73CE. For more on these sects, see, e.g., [SH1:xv-xxxviii], [E1; E2; E3], [GR:283-286], [SL:136-137].



In 1946-1947, in Israel, southeast of Jerusalem, it is said that a Bedouin lad threw a rock into a cave and heard it land on a jar of pottery. Or it may be that, as Silberman unrolls the story [SL:30ff.], the first of the documents were discovered by Ta'amireh tribesmen who actually were experienced hunters for antiquities. Thus begins the story of the Qumran-site find that is now called the Dead Sea Scrolls. Before we begin the story, however, we should indicate who lived there. Most scholars call these people the 'Essenes'. [BL:Ch.11], [FZ:§65] tell us what that term means and relates also that the historians, Flavius Josephus (ca. 38CE - ca. 100CE), Philo Judæus (ca. 20BCE - ca. 50CE), and Pliny the Elder (23CE - 79CE), described them as a Jewish sect beginning about the 2nd-century BCE. Cross [SH1:Ch.2], VanderKam [SH1:Ch.4] and other scholars also classify these people as Essenes. Qimron [QS1, QS2, SF:xvii,xxii], Schiffman [SH1:35-49] identify the Qumran sect as Sadducean. Other specialists, like Eisenman/Wise [EW:11], Golb [GB], et al. categorize them in different ways (see also [SH2:Ch.6], [SG:200-201] with reference particularly to [GZ]). The arguments about this will provide for future articles and books for many years. For further analysis, see [T2:xliv-xlviii].

[FZ:§§6-8] describes the main findings of the scrolls. We can divide them into four main categories in no particular order. One set of four parchments was sold to a Syrian Archbishop, Athanasius Yeshue Samuel. He eventually sold them to the Israeli, Yigael Yadin, in New York City. By chance, Yadin was notified that the four were advertised in the Wall Street Journal and surreptitiously through an agent paid \$250,000 for the little scraps. It is a fascinating story told in the Archbishop's autobiography [SM:Book3/139-201], also in [BL:Ch.1], [WN:1955/ChsI&VI], [SH1:Ch.1], [SH2:Ch.1], [SL:Ch.2]. Yadin's father, Eleazar L. Sukenik, a noted archeologist and palæographer, also recognized the whole find for what it was worth and bought three parchments. All of these were translated soon after they were found once they were 'cleaned'[SF:14] and were put into a museum in West Jerusalem. The third find was called the Copper Plate and it rests in Amman, Jordan. It tells of vast tons of gold and silver, which nobody has been able to find.

It is the fourth set that concerns us. Most of what is called "The Dead Sea Scrolls" ended up in the eastern part of Jerusalem, which was controlled by Jordan. The Israelis have controlled the "Dead Sea Scrolls" since 1967, when they captured East Jerusalem. Access to this fourth group was held by a certain small group, some of these Catholics. Among them were de Vaux, Cross, Milik and Strugnell. These people were allowed to continue working with them after the change into Israel's hands. At first, the scrolls were kept in deplorable condition; e.g., people were chain-smoking while working on them

to put them together. But, most of all, since the Israelis did not essentially interfere with the Dead Sea Scrolls after control, this clique did not let anyone from the outside examine them.

The group working on them was thus very secretive or at least obsessive. One reason might be because they wanted to make sure that the "Dead Sea Scrolls" should not conflict with Catholic doctrine [see BL:Ch.8,Ch.10]. Shanks [SH1:Ch.22] undermines this argument:

"The scroll editors answer to no one. ... They deeply resent the pressure that has been brought on them by outsiders. ... In their own terms, they will not be pushed around."

[SG:Ch.3/13-28] talks about this situation with regard to [BL] also giving an excoriating review: "... they had become victims of their own incompetence"; [VK1:198] says that the [BL] "conspiracy theory is baseless." Still, 40 and a few odd years is no way to strangle the study of these very important 2000-year old documents. As Geza Vermes in a lecture delivered in 1977 [T1:7] "coined the phrase" on "the greatest Hebrew manuscript discovery" : "'the academic scandal *par excellence* of the twentieth century'." Silberman relates how Shanks, Eisenman, et al. [SL:14] "spearheaded the [successful] campaign for free access to the scrolls" in the early 1990s. Vermes' more complete translation of the Dead Sea Scrolls [T1] and three others [T2], [T3], [T4] were done in the 1990s. Vermes [T1:5-8] also comments on the slow progress of editing these scrolls; see also [FZ:§§99-101].

2 The Hebrew Calendar from Ezra to Modern Times

No matter what period of time, the Jews were tied to the calendar [E1:91], [E2:382-383]. In fact, it is said that if the Jews did not have their calendar, with the festivals tied to it, there would be no reason for their existence. The reason is simple: the exodus from Egypt (1/15), the giving of the Torah (3/15 in the Essene calendar), the New Year, e.g., are the main reasons for their continuance. These are inexorably linked to the calendar.

From Ezra (5th century BCE) and continuing until approximately the 4th century CE, the calendar was decided upon by the Sanhedrin, the 71 members of the High Court [E1:488-489], [E2:1686], [E3:529]. It met in Jerusalem in its earlier days and decided on the new month at the time of the crescent of the new moon. Now the new moon appeared either 29 or 30 days after the preceding new moon (since the actual appearance occurs very close to 29 1/2 days apart). It is said that the Sanhedrin knew when the new months

occurred, but kept the calendar's secret to itself.

When Hillel II (330CE - 365CE) realized that the Hebrew calendar might be lost forever with the disbandment of the Sanhedrin, he published in 358CE-359CE rules for calculating the calendar [BB], [CH1], [SP] which are used to this day. It states that the year is 353, 354, or 355 days long, or 383, 384, or 385 days long. Now $354 = 6 \times (30 + 29)$. This would be the normal length of the year usually. However, so that certain of the holidays do not occur on certain weekdays, the second or third months are allowed to manipulate an extra day, disturbing the 30/29 pattern. Also, in order for Passover and Sukkot to occur in the spring and fall, occasionally an extra month of 30 days is added just before Passover.

The fact that 235 lunar months made up about 19 years was discovered by Meton in 432BCE [AV:14]. This was widely known by astronomers and Hillel II knew of this also. For the modern Hebrew calendar made up by Hillel II, the 3rd, 6th, 8th, 11th, 14th, 17th, and 19th years are the leap years ($12 \times 12 + 7 \times 13 = 235$). Now, the Sanhedrin also knew that at times an extra month in a year was required. It exercised the right to add it because, e.g., of the (a) vernal equinox, (b) the ripening of the barley crop, or (c) the blooming of the fruit trees [MM1:Ch.4], [MM2:Ch.4]. The actual complicated rules that the Sanhedrin followed are given in [MM1], [MM2].

Dating the Scrolls

	B.C.E.	C.E.
Composition	before 1000	c.1
Copying	c.250	c.50
Gathering	after 150	c.68

FIGURE 2: [SF:31]

3 The Two Essene (Dead-Sea-Scroll) Calendars

Though the Essenes' calendar(s) may have differed from that of other Jews (even of the same period), nevertheless, their observance of the laws was dependent upon the calendar. Josephus [JP], a much-relied upon historian of their times, unfortunately does not mention what they used for a calendar; so we will have to look in their documents for this aspect. For a study of ancient calendars, see [VX:II/Ch.12; IV/Ch.15].

As for the calendar, the Essenes actually had two of them. The first one, from the scrolls, was a lunar one. It had 354 [= $6 \times (29 + 30)$] days. As we indicated, the moon goes around the earth in approximately 29 1/2 days; that

is why we get this peculiar number of days. Since the holidays came from the second one, not much else is gleaned from the 354-day calendar. The second is much more complicated. It had 364 days and was solar. Since $3 \times 354 + 30 = 3 \times 364$, it is thought that an extra month of 30 days was added to the lunar one every three years (at the end of the three years) to make up for the difference to keep everything normal. See [EW:§§22-23] for translations of plates 4Q321, 4Q320 from the Hebrew, which delineate the equivalences. We now know that the solar (364) calendar was the mainstay with the luni-solar (354) calendar playing a much lesser rôle. [EW:108] indicates that the Essenes kept track of the luni-solar only to point out errors in case they would eventually be in charge in Jerusalem. 4QMMT [QS1, QS2, QS3, SH2:173-174] also points to a 364-day calendar. Yadin found evidence [YN1:173] that the same calendar was used by those at Masada, thus perhaps linking the two sects. In fact, while excavating, he found the *Book of Jubilees*, which will be discussed later, in its original Hebrew text [PM:186-189].

$7 \times 52 = 364$; this is very convenient because of the 7-day week, of which Saturday is very important. The first month began on Day 4 (Wednesday) because the moon and sun were created on the 4th day of creation. Don't forget that these Essenes were the "priests" of Jews and were very observant. Everything had to go by the (Old Testament) Pentateuch. The waving of the barley omer (count) is the next ceremony after Passover mentioned in the Bible; their interpretation is that it must be on "the day after the sabbath after Passover." Accordingly, it falls on 1/26. After fifty days there is the festival of weeks or first-fruits of wheat. It is called Shavuot, and is now taken to be the anniversary of the giving of the Torah. In the days of the Essenes, it was the day 3/15. [In current times, it is 3/6, and the first waving of the barley omer now is 1/16 (Nisan 16).]

Continuing: Two holidays not mentioned in the Pentateuch, which were celebrated by the Essenes:

5/3 = festival of wine - first fruits of the vine (50 days later);

6/22 = festival of oil - first fruits of oil (50 days after festival of wine).

Then there are: 7/1 = day of remembrance; 7/10 = day of atonement; 7/15 = beginning of the festival of booths: all mentioned in the Bible (Pentateuch). Note that Purim and Chanukah are not celebrated. The book of Esther (Purim) was not found in the Dead Sea Scrolls; the Maccabean (= Hasmonians) adventure (Chanukah) happened contemporaneously and there may have been a feud between the two groups.

Previous to the foundation of the Essene group, there are two other books which might have had an influence on the calendar: 1 Enoch and Jubilees

(which may have been written in the 2nd century BCE [BW:93-94], [VK2:99-101]). In 1 Enoch, we have exactly the two calendars used by the Essenes [EN1, EN2, PS1:§§72-82 (called by [MK2] *The Astronomical Book*)]; in the Jubilees, we have only the 364-day calendar [PS2:§6:vv. 29-38, 68]. In any detailed study of the Essene-calendar, these should be examined. In essence, the Jubilee calendar was the one used by the Qumran sect: surveys of this can be found in [FL:146-156] although no mention of the intercalation is mentioned; and in [VP:126-130]. In the latter, the author notes [VP:129-130]:

"One can ask oneself whether the refusal of the community to celebrate the common Jewish feast-days at the same time as the rest was not the most decisive reason for the formation of the sect. No certain answer can be given, because it is so difficult to determine the history of the community and the motives of their conduct as long as our data are incomplete."

The revelation in the scroll
of an important new festival: the
First Fruits of Wine.

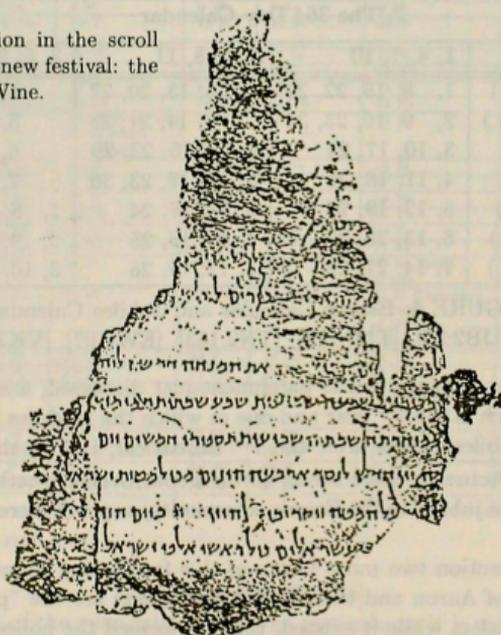


FIGURE 3:[YN4:92]

In one of the early books on the Qumran sect, [CR:36] notes:

"Finally, there is a series of calendrical works found in Cave IV, relating to the zodiac, to the calculation of the feast days, and the courses of the priests (*mishmarot*). Already the calendar materials found in published works have enabled scholars to solve a number of long-standing problems related to the solar calendar used in Jubilees and Enoch; now it appears that this calendar was at home among the Essenes at Qumrān, and that it is reflected in certain of the primitive Christian traditions in the Gospels."

In a footnote to this, one can find early works on the calendar materials. Also for this, see [YN2:205, fn.5]. An earlier work of the Jubilees was found in what is called the *Damascus Document*. Discovered in 1897 in a Cairo genizah (storage room for sacred worn-out texts), and sent to Cambridge University, Solomon Shechter was the main scholar at that time who uncovered and studied it [SH2:Ch.6], [VK2:47-48].

The 364 Day Calendar

Months:	1, 4, 7, 10	2, 5, 8, 11	3, 6, 9, 12
day 4 (Wed.)	1, 8, 15, 22, 29	6, 13, 20, 27	4, 11, 18, 25
day 5 (Thurs.)	2, 9, 16, 23, 30	7, 14, 21, 28	5, 12, 19, 26
day 6 (Fri.)	3, 10, 17, 24	1, 8, 15, 22, 29	6, 13, 20, 27
day 7 (Sat.)	4, 11, 18, 25	2, 9, 16, 23, 30	7, 14, 21, 28
day 1 (Sun.)	5, 12, 19, 26	3, 10, 17, 24	1, 8, 15, 22, 29
day 2 (Mon.)	6, 13, 20, 27	4, 11, 18, 25	2, 9, 16, 23, 30
day 3 (Tues.)	7, 14, 21, 28	5, 12, 19, 26	3, 10, 17, 24, 31

FIGURE 4: Essene Calendar and Jubilee Calendar
from [JB2:27], [TN1:176], [TN2:163], [EW:107], [VK2:55]

For notation: Jubilees is the parchment just discussed; a sabbatical year in the Pentateuch is the 7th year and one in which the land lies fallow in order to recoup; a jubilee comes after the 7th sabbatical, i.e., in the fiftieth year [TH:308-309]. Actually, there seems to be a controversy whether the 49th or 50th year was the jubilee in the Essene community, or parts thereof or additions to [BW:Ch.5].

I have to mention two more facets of this fascinating Essene solar calendar. The sons of Aaron and their male descendants are the "priests." In the temple in Jerusalem while it existed, they performed the holiest duties. Here it may have been spiritual. Anyway, there were 24 priests, as mentioned in I Chronicles [24:7-18; see, e.g., TH:1926-1927] and they were guards or watches [= *mishmarot*], who supposedly guarded from one sabbath to the next. (Remember that there are 7×52 weeks in the Essene solar calendar.) This meant

in one year that there were 2×24 watches. To make the schedule of watches or guards even with the years, we take 6 years; then there were 12×24 watches + $6 \times 4 = 6$ years = exactly 13 systems of watches. It is not very complicated for even an ordinary person to figure out.

The Festivals According to the Calendar of the Sect of the Scrolls

First Month	Second Month	Third Month	Fourth Month	Fifth Month	Sixth Month	Seventh Month
1 W. Beginning of Days of Consecration	1 F	1 Su	1 W	1 F	1 Su	1 W Day of Memorial
2 Th	2 Sa	2 M	2 Th	2 Sa	2 M	2 Th
3 F	3 Su	3 T	3 F	3 Su Feast of First Fruits of Wine	3 T	3 F
4 Sa	4 M	4 W	4 Sa	4 M	4 W	4 Sa
5 Su	5 T	5 Th	5 Su	5 T	5 Th	5 Su
6 M	6 W	6 F	6 M	6 W	6 F	6 M
7 T	7 Th	7 Sa	7 T	7 Th	7 Sa	7 T
8 W	8 F	8 Su	8 W	8 F	8 Su	8 W
9 Th	9 Sa	9 M	9 Th	9 Sa	9 M	9 Th
10 F	10 Su	10 T	10 F	10 Su	10 T	10 F Day of Atonement
11 Sa	11 M	11 W	11 Sa	11 M	11 W	11 Sa
12 Su	12 T	12 Th	12 Su	12 T	12 Th	12 Su
13 M	13 W	13 F	13 M	13 W	13 F	13 M
14 T Passover	14 Th	14 Sa	14 T	14 Th	14 Sa	14 T
15 W	15 F	15 Su Feast of First Fruits of Wheat	15 W	15 F	15 Su	15 W Feast of Booths
16 Th	16 Sa	16 M	16 Th	16 Sa	16 M	16 Th
17 F	17 Su	17 T	17 F	17 Su	17 T	17 F
18 Sa	18 M	18 W	18 Sa	18 M	18 W	18 Sa
19 Su	19 T	19 Th	19 Su	19 T	19 Th	19 Su
20 M	20 W	20 F	20 M	20 W	20 F	20 M
21 T	21 Th	21 Sa	21 T	21 Th	21 Sa	21 T
22 W	22 F	22 Su	22 W	22 F	22 Su Feast of Oil	22 W Eighth Day of Assembly
23 Th	23 Sa	23 M	23 Th	23 Sa	23 M Beginning of Feast of Wood Offering	23 Th
24 F	24 Su	24 T	24 F	24 Su	24 T	24 F
25 Sa	25 M	25 W	25 Sa	25 M	25 W	25 Sa
26 Su Day of Waving the Sheaf	26 T	26 Th	26 Su	26 T	26 Th	26 Su
27 M	27 W	27 F	27 M	27 W	27 F	27 M
28 T	28 Th	28 Sa	28 T	28 Th	28 Sa	28 T
29 W	29 F	29 Su	29 W	29 F	29 Su	29 W
30 Th	30 Sa	30 M	30 Th	30 Sa	30 M	30 Th
		31 T			31 T	

Yadin, Temple Scroll, I:118.

FIGURE 5:[SF:302-303]

[The rest of the year-calendar has no festivals; so it is omitted.]

A more difficult problem was the missing day or two of the year. Otherwise, the year would backslide from the first month of Nisan (originally Spring) becoming Winter, Fall, Summer, etc. And the first holiday, Passover, was

always supposed to be happening in Spring. Nowadays, the Hebrew luni-solar calendar adds an extra month 7 times in 19 years, and there is no problem. What about the 364-day calendar? Having survived for at least two centuries, the Qumran-group must have known about and solved "this problem." It would have to be very delicate, because a change in the calendar was very serious—throwing off the God-given festivals by only one day was a formidable predicament for these "priests."

So, to sum up: There are essentially three questions about what the Essenes did to change their calendar to coordinate the holidays with the seasonal reality. These are not only *astronomical*, but also *arithmetical*, and *mishmarotical*. Firstly, we have to worry about Passover slipping into Winter (since the year is *approximately* $365\frac{1}{4}$ days long). Secondly, since the Essenes have two calendars—one solar and the other luni-solar with the solar one dominant, we have to determine how the change to the solar one (364-day calendar) affected the luni-solar one (354-day calendar). And thirdly, we have to determine the changes to the watches or mishmarot, since the plan above (with the 13 systems of watches for the 6 years) seemed to be realizable. Actually, we shall only look at the first problem, for that is mainly the problem that the articles have considered (see [VK2:Bibliography, 124-128] for references on Dead-Sea-Scroll calendar papers). The other two questions have not really been discussed at length and are of lesser importance, but nevertheless of some interest. {[VK2:84-86] notes that solar and lunar calendars in a six-year cycle from 4Q321 are studied in [TN3].}

Let us examine, first of all, what the holiday 364-day calendar looked like: These holidays are confirmed by several scrolls, including the Temple Scroll [VK2:65-70], [YN3:118], [YN4:89-96; 101-104; 109-111] (see FIGURE 5).

Now there was a question of intercalation (i.e., the addition of days, months or years "to bring it [the 364-day calendar] into line with reality" [BW:125]). This, of course, *was and is* a serious problem. [BW:126-127] gives seven of many suggestions for proposed intercalation. In approximately three centuries of existence (ca. 250BCE - 68CE) the Essenes would have gone back a year plus without intercalation—yet there is no method in the Dead Sea Scrolls parchments for intercalation. According to the Pentateuch {[TH:466-467: Deuteronomy (16:1)]}, Passover must be in the springtime.

However, from the Pentateuch, Tanach (Old Testament + Prophets + Writings), 1 Enoch and the Jubilees (Pseudepigrapha) there have been hints, leading to many scholarly conjectures in articles on intercalation. We give a few: either the most promising mathematically or those widely known. This has to be modified by what [BW:140] says:

"So the Essenes may well have been content, like the Moslems afterwards, to allow their holy days to revolve through all the seasons, while they set their hopes on the coming era of righteousness, when nature would return to its proper course."

In other words – *no intercalation*: the view also of [SG:166-174].

1. [VK2:54] reports of Jaubert [JB2], that in the Book of Jubilees "the year consists of 364 days exactly and in which there is no evidence of intercalation." [BW:126] reports from [JB1:Appendix II]: "Mlle Annie Jaubert has adduced possible rabbinical evidence for a different system—the intercalation of 35 days after every 28 years. This would reconcile the discrepancy almost exactly." Of Jaubert's Jubilee calendar, [TN1:187ff.; TN2:173ff.] (see again FIGURE 4 for the Jubilee calendar) believes that the Qumran sect celebrated each day from sunrise to sunset (day to night), thereby setting it off again in a different way.

2. In [BW:126; MK1; VK2:58-60]: A 29-day month to be intercalated after each 24-year cycle (four of the sexennial cycles). Milik mentions that $24 \times 6 = 144$ years would be necessary for the mishmarot or watches to be rectified. This would make up for the missing year-days + leap years "thus achieving an almost exact conformity with the true reckoning" [BW:126; MK1:110].

3. In 1930, [ZN] conjectured that the jubilee "was observed as a period of 49 days intercalated after the Day of Atonement every 49th year. This would have the effect of roughly reconciling the 364-day calendar with the true solar year of approximately $365\frac{1}{4}$ days" [BW:126]. [HG] agrees, interpreting Leviticus (25:8) as: "And the days of the seven weeks of years, forty-nine, shall be for thee a year," as reported in [BW:126].

4. There are other selections. For example, "[LN:85] adopts a suggestion of [TZ:127ff.] that 7 days were added at the end of every 7th year and an extra 7 at the end of every 28th year." [CG:79-81] would add the extra 7 "to the 49th year" instead. These "would, over the whole period, reconcile the 364-day with the true solar year with good fits," as recorded in [BW:127].

5. [GM:379-398] proposes a rather complicated scheme obtained from 4Q319. We put it below to show the complexity of the intercalation. [VK2:83] claims that "The exact form of [his] intercalary hypothesis proved to be inaccurate when the full text of 4Q319 became available, but the basic contours of his system may still be valid." {In FIGURE 6, signs = omens = otot [Hebrew], first seen in the Pentateuch in Genesis (1:14).}

THE CALENDRIAL TEXTS

	True Solar Year	364-day solar year	difference
1 year	365.25	364	1.25
7 years	2556.75	2548	8.75
49 years	17,897.25	17,836	61.25
343 years	125,280.75	124,852	428.75

Methods for intercalating the extra 428.75 days

1 7 days every 7th year = 343

2 7 days at each of the 12 signs = 84

3 7 days over four units of 343 years, that is, 1.75 for each 343-year period = 1.75

Total = 428.75

FIGURE 6: [VK2:83]

4 Conclusion

Further investigation, perhaps with forthcoming calendar scrolls, will need to be done. I think these hypotheses, especially #5, are very speculative. The Essenes would have to know how an exact calendar operates. Even Pope Gregory XIII (1582CE) did not know although he had better knowledge than that of Julius Caesar (45BCE), who relied on the Egyptian astronomer Sosigenes. Thus the world went from an Egyptian calendar (365 days) to the Julian calendar ($365\frac{1}{4}$ days) to the Gregorian calendar (97 leap years in 400 years), each one being more precise. The earth changes its movement around the sun each century; so eventually our "fixed" calendar will have to be changed because there will be too many leap years (see [CH3:11], [CH4]).

References

- [AV] Asimov, Isaac, *Asimov's Biographical Encyclopedia of Science and Technology* (2nd revised ed.); Doubleday & Co., Inc.; Garden City, NY (1982)
- [BB] Burnaby, Rev. Sherrard Beaumont, *Elements of the Jewish and Muhamadan Calendars*; George Bell & Sons; London, UK (1901)
- [BL] Baigent, Michael & Leigh, Richard, *The Dead Sea Scrolls Deception*; Summit Books; NYC; 1991
- [BR] Brown, Steven M. *Higher and Higher: Making Jewish Prayer Part of Us*; United Synagogue of Conservative Judaism NYC 150 (1980)

- [BW] **Beckwith, Roger T** *Calendar and Chronology, Jewish and Christian*; EJ Brill Leiden / NYC / Koln; 1996
- [CG] **Burgmann, Hans** *Die Interkalation in den sieben Jahrwochen des Sonnenkalenders*; Revue de Qumran X, no. 37 (September 1979)
- [CH1] **Cohen, Edward L** *The Hebrew Calendar Simplified*; Proceedings of Canadian Society for History and Philosophy of Mathematics 7; University of Calgary; Calgary, AB (June 8-10,1994)
- [CH2] **Cohen, Edward L** *Calendars of the Dead-Sea-Scroll Sect*; Proceedings of Canadian Society for History and Philosophy of Mathematics 12; 59-71; University of Toronto; Toronto, ON (July 15-17, 1999)
- [CH3] **Cohen, Edward L** *Adoption and Reform of the Gregorian Calendar*; Math Horizons VII, #3 5-11 (February 2000)
- [CH4] **Cohen, Edward L** *Simon Newcomb and the Leap-Year Problem*; Proceedings of the Canadian Society for the History and Philosophy of Mathematics 13 McMaster University; Hamilton, ON (10-12 June 2000)
- [CR] **Cross, Frank Moore, Jr** *The Ancient Library of Qumran*; Doubleday & Co., Inc.; Garden City, NY -1958
- [DA] **Danziger, Rabbi Hillel (translator & annotator)** *The ArtScroll Tehillim*; Mesorah Publications, Ltd; Brooklyn, NY; Ashrei: 313, fn.14 (1988)
- [E1] **de Haas, Jacob (ed.)** *The Encyclopedia of Jewish Knowledge*; Behrman's Jewish Book House; NYC (1934)
- [E2] **Roth, Cecil / Wigoder, Geoffrey** *The New Standard Jewish Encyclopedia (5th ed.)*; Doubleday & Co., Inc. Garden City, NY (1959...1977)
- [E3] **Wigoder, Geoffrey (ed.)** *Everyman's Judaica*; Keter Publ. House Jerusalem Ltd (1975)
- [EN1] **Charles, RH (ed.)** *Book of Enoch (1 Enoch)*; from The Apocrypha and Pseudepigrapha of the Old Testament (Vol. II, 163-281); Clarendon Press Oxford, UK (1913)
- [EN2] **Charles, RH (trans.)** *The Book of Enoch*; SPCK London (1917...1982)
- [EW] **Eisenman, Robt H & Wise, Michael** *The Dead Sea Scrolls Uncovered*; Element Books Ltd; UK / USA / Australia (1992)
- [FL] **Fisdel, SA** *The Dead Sea Scrolls: Understanding Their Spiritual Message*; Jason Aronson Inc.; Northvale, NJ; (1997)
- [FZ] **Fitzmyer, SJ, Joseph A** *Responses to 101 Questions on the Dead Sea Scrolls*; Paulist Press; Mahwah, NJ (1992)
- [GB] **Golb, Norman** *Who Wrote The Dead Sea Scrolls*; Scribner; NYC (1995)

- [GM] **Glessmer, U** *Der 364-Tage-Kalender und die Sabbatstruktur seiner Schaltungen in ihrer Bedeutung für den Kult*; in DR Daniels / U Glessmer / M Rösel (eds); Ernten, was man sät: Festschrift Klaus Koch zu seinem 65. Geburtstag; Neukirchener Verlag; Neukirchen-Vluyn (1991)
- [GR] **Greenberg, Rabbi Irving** *The Jewish Way*; Simon & Schuster Inc.; NYC (1988)
- [GZ] **Ginzburg, Louis** *An Unknown Jewish Sect [originally: Eine unbekannte jüdische Sekte*; Jewish Theological Seminary of America; NYC (1922...1976)
- [HG] **Hoenig, SB** *Sabbatical Years and the Year of Jubilee*; Jewish Quarterly Review 59; 222-236 (1968/69)
- [JB1] **Jaubert, Mlle Annie** *La date de la cène: calendrier biblique et liturgie chrétienne*; Études bibliques; Gabalda; Paris (1957)
- [JB2] **Jaubert, Mlle Annie** *The Date of the Last Supper*; Alba; Staten Island, NY (1965) {trans. I. Rafferty from French of [JB1]}
- [JP] **Josephus, Flavius** *The Complete Works of Josephus*; Kregel Pubs; Grand Rapids, MI (1960...1981)
- [LN] **Leaney, ARC** *The Rule of Qumran and its Meaning*; SCM; London (1966)
- [MK1] **Milik, Joséf T** *Ten Years of Discovery in the Wilderness of Judea (J Strugnell - trans.)*; SCM Press Ltd; London (1959) [French ed. 1957]
- [MK2] **Milik, Joséf T** *The Books of Enoch: Aramaic Fragments of Qumrân Cave 4*; Oxford: Clarendon Press (1976)
- [MM1] **Maimonides, Moses (Moses ben Maimon)** *Sanctification of the New Moon (Kiddush Hachodesh)*; The Code of Maimonides, Book 3, Treatise 8 (translated from Hebrew by Solomon Gandz); Yale University Press; New Haven, CT (1956, 1967)
- [MM2] **Maimonides, Moses (Moses ben Maimon)** *Sanctification of the New Moon*; (Mishneh Torah Series: Hilchot Kiddush Hachodesh) Vol. 14 (translated from Hebrew with extensive footnotes by Rabbi Eliyahu Touger); Moznaim Publishing Corp. NYC / Jerusalem (1993)
- [PM] **Pearlman, Moshe** *The Zealots of Masada: Story of a Dig*; Charles Scribner's Sons; NYC (1967)
- [PS1] **Charlesworth, James H (ed.)** *The Old Testament: Pseudepigrapha*; Vol. 1: Apocalyptic Literature and Testaments; Doubleday & Co., Inc.; Garden City, NY (1983)
- [PS2] **Charlesworth, James H (ed.)** *The Old Testament: Pseudepigrapha*; Vol. 2: Expansions of the "Old Testament" and Legends, Wisdom and Philosophical Literature, Prayers, Psalms, and Odes, Fragments of Lost Judeo-Hellenistic Works; Doubleday & Co., Inc.; Garden City, NY (1985)

- [QS1] **Qimron, E / Strugnell, J** *An Unpublished Halakhic Letter from Qumran*; 400-407 Janet Amitai (ed.); Biblical Archaeology Today; Proceedings of the International Congress on Biblical Archaeology; Israel Exploration Society; Jerusalem (April 1984)
- [QS2] **Qimron, E / Strugnell, J** *An Unpublished Halakhic Letter from Qumran*; Israel Museum Journal 4; 9-12 (1985)
- [QS3] **Qimron, E / Strugnell, J** *Qumran Cave 4. V: Miqsat Ma'a's e Ha-Torah*; Discoveries in the Judean Desert 10; Clarendon; Oxford, UK (1994)
- [SF] **Schiffman, Lawrence H** *Reclaiming the Dead Sea Scrolls*; Jewish Publ. Soc. (1994); Doubleday (1995)
- [SG] **Stegemann, Hartmut** *The Library of Qumran*; Eerdmans Publ. Co.&Brill; Grand Rapids, MI (1993, 1998)
- [SH1] **Shanks, Hershel (ed.)** *Understanding the Dead Sea Scrolls*; Random House; NYC (1992)
- [SH2] **Shanks, Hershel** *The Mystery and Meaning of the Dead Sea Scrolls*; Random House; NYC (1998)
- [SL] **Silberman, Neil Asher** *The Hidden Scrolls*; Riverhead Books; NY (1994)
- [SM] **Samuel, Athanasius Yeshue** *Treasure of Qumran: My Story of the Dead Sea Scrolls*; Hodder & Stoughton; London (1968)
- [SP] **Spier, Arthur** *The Comprehensive Hebrew Calendar (3rd revised ed.)*; Feldheim Publishers Spring Valley, NY / Jerusalem (1986)
- [T1] **Vermes, Geza** *The Complete Dead Sea Scrolls in English*; Allen Lane; The Penguin Press; NYC (1962...1997)
- [T2] **García Martínez, Florentino** *The Dead Sea Scrolls Translated: The Qumran Texts in English (2nd ed.)*; EJ Brill - Leiden / NYC / Cologne; William B Eerdmans - Grand Rapids, MI (1992...1996)
- [T3] **Wise, M. / Abegg, M., Jr / Cook, E.** *Dead Sea Scrolls: A New Translation*; HarperSanFrancisco; San Francisco (1996)
- [T4] **Abegg, Martin, Jr / Flint, Peter / Ulrich, Eugene** *The Dead Sea Scrolls Bible*; HarperSanFrancisco; San Francisco (1999)
- [TH] **Scherman, Rabbi Nosson (ed.)** *Tanach (Torah / Prophets / Writings)*; The ArtScroll Series; Mesorah Publ., Ltd; Brooklyn, NY (December 1996)
- [TN1] **Talmon, Shemaryahu** *The Calendar Reckoning of the Sect from the Judean Desert*; in Scripta Hierosolymitana IV; Aspects of the Dead Sea Scrolls; ed. by C Rabin & Y Yadin; Magnes Press (The Hebrew University); Jerusalem (1958)

- [TN2] **Talmon, Shemaryahu** *The World of Qumran from Within*; Magnes / Brill Jerusalem / Leiden (1989)
- [TN3] **Talmon, S / Knoll, I** *A Calendrical Scroll from a Qumran Cave: Miš marot B^a, 4Q321*; in DP Wright / DN Freedman / A Hurvitz (eds); *Studies in Biblical, Jewish, and Near Eastern Ritual, Law, and Literature*; in honor of Jacob Milgrom; Eisenbrauns; Winona Lake, IN (1995)
- [TZ] **Testuz, M** *Les idées religieuses du livre des Jubilés*; Droz; Genève (1960)
- [VK1] **VanderKam, James C** *The Dead Sea Scrolls Today*; Wm B Eerdmans Publ. Co.; Grand Rapids, MI (1994)
- [VK2] **VanderKam, James C** *Calendars in the Dead Sea Scrolls: Measuring Time*; Routledge; London / NYC (1998)
- [VP] **Van Der Ploeg** *The Excavations at Qumran*; Longmans, Green & Co.; London / NYC / Toronto (1958)
- [VX] **de Vaux, Roland, OP** *Ancient Israel: Its Life and Institutions*; Wm B Eerdmans Publ. Co.; Grand Rapids, MI; 1997 [1958, 1960 in French English translation 1961]
- [WN] **Wilson, Edmund** *The Dead Sea Scrolls 1947 - 1969*; revised and expanded version of *The Scrolls from the Dead Sea*; Oxford University Press; NYC (1955...1969)
- [YN1] **Yadin, Yigael** *Masada: Herod's Fortress and the Zealots' Last Stand*; Weidenfeld and Nicolson, London (1966)
- [YN2] **Yadin, Yigael** *The Scroll of the War of the Sons of Light against the Sons of Darkness*; Oxford University Press; London (1962)
- [YN3] **Yadin, Yigael** *The Temple Scroll (3 Vols)*; Israel Exploration Society (1977 [Hebrew] /1983)
- [YN4] **Yadin, Yigael** *The Temple Scroll: The Hidden Law of the Dead Sea Sect*; Random House; NYC (1985)
- [ZN] **Zeitlin, Solomon** *Notes relatives au calendrier juif*; Revue des Études Juives 89; 349-359 (1930)

Note: There is a misprint in Cubo Matemática Educacional 2, Año 2000, page 3: on line (b), instead of $5 + \left\{ \frac{N-1}{4} \right\}$, read $5 \left\{ \frac{N-1}{4} \right\}$.