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The history of the Jewish **calendar** may be divided into three periods—the Biblical, the Talmudic, and the post-Talmudic. The first rested purely on the observation of the sun and the moon, the second on observation and reckoning, the third entirely on reckoning.

The study of astronomy was largely due to the need of fixing the dates of the festivals. The command (Deut. xvi. 1), "Keep the month of Abib," made it necessary to be acquainted with the position of the sun; and the command, "Also observe the moon and sanctify it," made it necessary to study the phases of the moon.

The oldest term in Hebrew for the science of the **calendar** is **קביעותא דירחא** ("fixing of the month"); later **קדוש החדש** ("sanctification of the new moon"); **קדוש החדש על פי ראייה** ("sanctification of the new moon by means of observation"); **פי חשבון קדוש החדש על** ("sanctification of the new moon by means of reckoning"); **יריעה בקביעותא דירחא** ("science of fixing the month"); **הלכות קדוש החדש** ("rules for the sanctification of the new moon"). Among other names besides these we find **סוד העבור** ("the secret of intercalation"). The medieval and modern name is **לוח**.

Babylonian Calendar.

The Babylonian year, which influenced the French time reckoning, seems to have consisted of 12 months of 30 days each, intercalary months being added by the priests when necessary. Two Babylonian **calendars** are preserved in the inscriptions, and in both each month has 30 days as far as can be learnt. In later times, however, months of 29 days alternated with those of 30. The method of intercalation is uncertain, and the practise seems to have varied.

The Babylonian years were soli-lunar; that is to say, the year of 12 months containing 354 days was bound to the solar year of 365 days by intercalating, as occasion required, a thirteenth month. Out of every 11 years there were 7 with 12 months and 4 with 13 months.

Strassmeier and Epping, in "Astronomisches aus Babylon," have shown that the ancient Babylonians were sufficiently advanced in astronomy to enable them to draw up almanacs in which the eclipses of the sun and moon and the times of new and full moon were predicted ("Proc. Soc. Bib. Arch., 1891-1892," p. 112).

The Talmud (Yerushalmi, Rosh ha-Shanah i. 1) correctly states that the Jews got the names of the months at the time of the Babylonian exile.

There is no mention of an intercalary month in the Bible, and it is not known whether the correction was applied in ancient times by the addition of 1 month in 3 years or by the adding of 10 or 11 days at the end of each year.

Bound Lunar Year.

Astronomers know this kind of year as a bound lunar year. The Greeks had a similar year. Even the Christian year, although a purely solar year, is forced to take account of the moon for the fixing of the date of Easter. The Mohammedans, on the other hand, have a free lunar year.

It thus seems plain that the Jewish year was not a simple lunar year; for while the Jewish festivals no doubt were fixed on given days of lunar months, they also had a dependence on the position of the sun. Thus the Passover Feast was to be celebrated in the month of the wheat harvest (אביב), and the Feast of Tabernacles, also called תג האסיף, took place in the fall. Sometimes the feasts are mentioned as taking place in certain lunar months (Lev. xxiii.; Num. xxviii., xxix.), and at other times they are fixed in accordance with certain crops; that is, with the solar year.

In post-Talmudic times Nisan, Siwan, Ab, Tishri, Kislew, and Shebat had 30 days, and Iyyar, Tammuz, Elul, Heshwan, Tebet, and Adar, 29. In leap-year, Adar had 30 days and We-Adar 29. According to Pirke Rabbi Eliezer, there was a lunar solar cycle of 48 years. This cycle was followed by the Hellenists, Essenes, and early Christians.

In the times of the Second Temple it appears from the Mishnah (R. H. i. 7) that the priests had a court to which witnesses came and reported. This function was afterward taken over by the civil court (see B. Zuckermann, "Materialien zur Entwicklung der Altjüdischen Zeitrechnung im Talmud," Breslau, 1882).

The fixing of the lengths of the months and the intercalation of months was the prerogative of the Sanhedrin, at whose head there was a patriarch or נשיא. The entire Sanhedrin was not called upon to act in this matter, the decision being left to a special court of three. The Sanhedrin met on the 29th of each month to await the report of the witnesses.

From before the destruction of the Temple certain rules were in existence. The new moon can not occur before a lapse of $29\frac{1}{2}$ days and $\frac{2}{3}$ of an hour. If the moon could not be exactly determined, one month was to have 30 days and the next 29. The full months were not to be less than 4 nor more than 8, so that the year could not be less than 352 days nor more than 356. After the destruction of the Temple (70 C.E.) Johanan ben Zakkai removed the Sanhedrin to Jabneh. To this body he transferred decisions concerning the **calendar**, which had previously belonged to the patriarch. After this the witnesses of the new moon came direct to the Sanhedrin.

Empirical Determination of Leap-Year.

Every two or three years, as the case might be, an extra month was intercalated. The intercalation seems to have depended on actual calculation of the relative lengths of the solar and lunar years, which were handed down by tradition in the patriarchal family. Moreover, it was possible to judge by the grain harvest. If the month of Nisan arrived and the sun was at such a distance from the vernal equinox that it could not reach it by the 16th of the month, then this month was not called Nisan, but Adar Sheni (second).

On the evening before the announcement of the intercalation the patriarch assembled certain scholars who assisted in the decision. It was then announced to the various Jewish communities by letters. To this epistle was added the reason for the intercalation. A copy of such a letter of Rabban Gamaliel is preserved in the Talmud (Sanh. xi. 2).

The country people and the inhabitants of Babylonia were informed of the beginning of the month by fire-signals, which were readily carried from station to station in the mountain country. These signals could not be carried to the exiles in Egypt, Asia Minor, and Greece, who, being accordingly left in doubt, celebrated two days as the new moon.

Owing to the weather it was frequently impossible to observe the new moon. In order to remove any uncertainty with regard to the length of the year on this account, it was ordained that the year should not have less than 4 nor more than 8 full months. After the fixing of the **calendar** it was settled that the year should not have less than 5 nor more than 7 full months.

R. Gamaliel II. (80-116 C.E.) used to receive the reports of the witnesses in person, and showed them representations of the moon to test their accuracy. On one occasion he fixed the first of Tishri after the testimony of two suspected witnesses. The accuracy of the decision was disputed by Rabbi Joshua, who was thereupon commanded by the patriarch to appear before him prepared for travel on the day which was, according to his (Joshua's) calculation, the Day of Atonement, an order with which he most reluctantly complied.

During the persecutions under Hadrian and in the time of his successor, Antoninus Pius, the martyr Rabbi Akiba and his pupils attempted to lay down rules for the intercalation of a month.

Under the patriarchate of Simon III. (140-163) a great quarrel arose concerning the feast-days and the leap-year, which threatened to cause a permanent schism between the Babylonian and the Palestinian communities—a result which was only averted by the exercise of much diplomacy.

Talmudic Period.

Under the patriarchate of Rabbi Judah I., surnamed "the Holy" (163-193), the Samaritans, in order to confuse the Jews, set up fire-signals at improper times, and thus caused the Jews to fall into error with regard to the day of the new moon. Rabbi Judah accordingly abolished the fire-signals and employed messengers. The inhabitants of countries who could not be reached by messengers before the feast were accordingly in doubt, and used to celebrate two days of the holidays. By this time the fixing of the new moon according to the testimony of witnesses seems to have lost its importance, and astronomical calculations were in the main relied upon.

One of the important figures in the history of the **calendar** was Samuel (born about 165, died about 250), surnamed "Yarḥinai" because of his familiarity with the moon. He was an astronomer, and it was said that he knew the courses of the heavens as well as the streets of his city (Ber. 58b). He was director of a school in Nehardea (Babylonia), and while there arranged a **calendar** of the feasts in order that his fellow-countrymen might be independent of Judea. He also

calculated the **calendar** for sixty years. His calculations greatly influenced the subsequent **calendar** of Hillel. According to Bartolucci his tables are preserved in the Vatican. A contemporary of his, R. Adda (born 183), also left a work on the **calendar**.

Mar Samuel reckoned the solar year at 365 days and 6 hours, and Rab Adda at 365 days, 5 hours, 55 minutes, and $25 \frac{25}{57}$ seconds.

In 325 the Council of Nice was held, and by that time the equinox had retrograded to March 21. This council made no practical change in the existing civil **calendar**, but addressed itself to the reform of the Church **calendar**, which was soli-lunar on the Jewish system. Great disputes had arisen as to the time of celebrating Easter. Moreover, the Church was not fully established, many Christians being still simply Jewish sectarians. A new rule was therefore made, which, while still keeping Easter dependent on the moon, prevented it from coinciding with Passover.

Under the patriarchate of Rabbi Judah III. (300-330) the testimony of the witnesses with regard to the appearance of the new moon was received as a mere formality, the settlement of the day depending entirely on calculation. This innovation seems to have been viewed with disfavor by some members of the Sanhedrin, particularly Rabbi Jose, who wrote to both the Babylonian and the Alexandrian communities, advising them to follow the customs of their fathers and continue to celebrate two days, an advice which was followed, and is still followed, by the majority of Jews living outside of Palestine.

Under the reign of Constantius (337-361) the persecutions of the Jews reached such a height that all religious exercises, including the computation of the **calendar**, were forbidden under pain of severe punishment. The Sanhedrin was apparently prevented from inserting the intercalary month in the spring; it accordingly placed it after the month of Ab (July-August).

Post-Talmudic Period.

The persecutions under Constantius finally decided the patriarch, Hillel II. (330-365), to publish rules for the computation of the **calendar**, which had hitherto been regarded as a secret science. The political difficulties attendant upon the meetings of the Sanhedrin became so numerous in this period, and the consequent uncertainty of the feast-days was so great, that R. Huna b. Abin made known the following secret of the **calendar** to Raba in Babylonia: Whenever it becomes apparent that the winter will last till the 16th of Nisan, make the year a leap-year without hesitation.

This unselfish promulgation of the **calendar**, though it destroyed the hold of the patriarchs on the scattered Judeans, fixed the celebration of the Jewish feasts upon the same day everywhere. Later Jewish writers agree that the **calendar** was fixed by Hillel II. in the year 670 of the Seleucid era; that is, 419 A.M. or 359 C.E. Some, however, as Isaac Israeli, have fixed the date as late as 500. Saadia afterward formulated **calendar** rules, after having disputed the correctness of the **calendar** established by the Karaites. That there is a slight error in the Jewish **calendar**—due to inaccuracies in the length of both the lunar and the solar years upon which it is based—has been asserted by a number of writers.

Error in the Calendar.

According to Isidore Loeb the Jewish cycle in 19 years exceeds the Gregorian by 2 hours, 8 minutes, and 15.3 seconds. This makes a difference in a hundred cycles (1900 years) of 8 days, 21 hours, 45 minutes, and 5 seconds ("Tables du Calendrier Juif," p. 6, Paris, 1886).

The assumed duration of the solar year is 6 minutes, 39 $\frac{25}{57}$ seconds in excess of the true astronomical value, which will cause the dates of the commencement of future Jewish years, which are so calculated, to advance from the equinox a day in error in 216 years ("Encyc. Brit." s. v. "Calendar," 9th ed., iv. 678).

The following calculation of the differences between the Jewish and Gregorian lengths of the year and month was privately made for the writer by Prof. William Harkness, formerly astronomical director of the United States Naval Observatory at Washington:

1 year = 365d. 05h. 997 $\frac{12}{19}$ ḥalaḳim or 365d. 05h. 55m. 25.439 s. 48m. 46.069 s. true value (29d. 12h. 793 ḥalaḳim) 235 = 6939d. 16h. 595 ḥalaḳim = 19 years 29d. 12h. 44m. $\frac{3}{5}$ s. True value = 29d. 12h. 44m. 02.841s.

According to these calculations the Jewish year exceeds the Gregorian by 6 m. 39.37s. and the Jewish month by .492 s. Insignificant as these differences may appear, they will cause a considerable divergence in the relations between Nisan and spring as time goes on, and may require a Pan-Judaic Synod to adjust.

Writers on the Calendar:

Mashallah, 754-813; Sahl ben Rabban al-Ṭabari, 800; Sind ben Ali, 829-832; Shabbethai b. Abraham Donolo, 949; Ḥasan, judge of Cordova, 972; Abraham b. Ḥiyya, d. 1136; Abraham ibn Ezra, 1093-1168; Isaac b. Joseph Israeli, 1310; Immanuel b. Jacob of Tarrascon, 1330-1346; Elia Misraḥi, d. 1490; Abraham b. Samuel Zacuto, professor of astronomy at Saragossa, 1492, Moses Isserles, d. 1573; David Gans (d. 1613), a friend of Kepler and Tycho Brahe; Raphael Levi Hannover, 1734; Israel Lyons, 1773, member of an English polar expedition. Besides the following works of the Talmudic period: *ברייטא דסוד העבור*, Baraita of the secret of intercalation (R. H. xx. 2); *ברייטא דרב אדא: ברייתא דשמואל* (Pirḳe de Rabbi Eliezer ha-Gadol b. Hyrcanus).

Bibliography: L. M. Lewisohn, *Geschichte und System des Jüdischen Kalenderwesens*, Leipsic, 1853 (Schriften heraus-gegeben vom Institute zur Förderung der Israelitischen Literatur); also the works of Steinschneider, Scaliger, and Ideler. J. A.