# HEBREW DATING

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*Iudaicus computus, omnium qui hodie extant*
*antiquissimus, articiosissimus, et elegantissimus.*
*[Of all methods of intercalation that exist today, the Jewish calculation*
*is the oldest, the most skillful, and the most elegant.]*

—Joseph Justus Scaliger: *De Emendatione Temporum* (1593)

## 1. Introduction

There are scores of different calendrical systems employed by societies around the world today; these include calendars in widespread use, like the Gregorian, Hebrew, Islamic, and Chinese, as well as more obscure calendars, such as the Coptic and Bahá'í, plus many more that are of historical importance like the Egyptian, Julian, Mayan, Old Hindu, and French Revolutionary. The Jewish Diaspora has resulted in the documenting of births and deaths in such a variety of calendars that the job of the genealogist is complicated indeed!

Unfortunately, information that is sufficiently detailed to allow conversion of dates has been difficult to find for many calendars (such as the Chinese, Hindu and Persian). Published material is often inaccessible, ecclesiastically oriented, incomplete, inaccurate, based on extensive tables, overburdened with extraneous material, focused on shortcuts for hand calculation to avoid complicated arithmetic or to check results, or unavailable in Western languages. At the same time, most existing computer programs are proprietary, incomplete, or inaccurate—even the (now) nearly universal Gregorian calendar is incorrectly implemented in most spreadsheets.

Our project to remedy this situation has continued to develop over a 15-year period, and resulted in several papers and books. It began with computer code that provided calendar and diary features within GNU Emacs (a popular text editor), and which engendered a deluge of inquiries and requests from around the globe, among them from *refuseniks* who were using the freely-available program to determine dates of Jewish interest.

Below we give some brief historical remarks about calendars (civil, Hebrew, and Islamic), but our primary focus is the problems and pitfalls faced by genealogists in dealing with dates, along with useful resources.

## 2. Civil Calendars

The Gregorian calendar—designed at the end of the 16th century and used today throughout the world—is purely solar in nature. It was instituted by Pope Gregory XIII to replace the Julian (old style) calendar. A papal bull proclaimed that Thursday, October 4, 1582 C.E. would be followed by Friday, October 15, 1582 in the new-style (Gregorian) calendar. Catholic countries (Spain, Portugal, Italy, and the Catholic states in Germany) switched immediately to the new calendar, but Protestant countries resisted and for the most part adopted it only in the 18th century. Some countries did not adopt it until the 20th century, for example Russia in 1918 (thus the "October Revolution" took place in November on the Gregorian calendar!) and Turkey in 1927. Even relatively recent documents might refer to Julian dates. An extensive list of dates of adoption of the Gregorian calendar can be found in the *Ephemeris Supplement.*

By universal current custom, the new Gregorian year number begins on January 1. There have, however, been other customs—parts of Europe began the New Year variously on March 1, March 25, Easter, September 1, and Christmas. For example, in England the commencement of the ecclesiastical year on March 25 in the 16th and 17th centuries means that a date like February 1, 1660, leaves the intended year in doubt. Such confusion led to the practice of writing a hyphenated year giving both year numbers: February 1, 1660-1.

## 3. The Hebrew Calendar

In the Hebrew lunisolar calendar, days begin at sunset, months begin with the new moon, and years are kept in tune with the seasons by the intercalation of a leap month every 2-3 years. In ancient and classical times, the month began with the observation by at least two witnesses of the crescent moon; leap months were added by the Jerusalem authorities as the need arose. The fixed calendar, attributed to the 4th-century patriarch, Hillel II, is based on a mean month of 29d 12h 44m 3⅓s and on the 19-year Metonic cycle comprising 7 leap years, each containing 13 months. The average year length is 365.2468 days, which is slightly longer than the mean tropical year; on account of the accumulated discrepancy, Passover often occurs nowadays more than a month after the vernal equinox. The fixed calendar also incorporates several rules for delaying the onset of the year, as a consequence of which common years have 353-355 days, leap years have 383-385 days, and Passover never begins on Monday, Wednesday, or Friday. The details of the fixed calendar were finalized by the 10th century.

The Karaite lunisolar calendar is still observation-oriented; the Samaritan calendar is based on astronomical calculations.

In the Bible, months are usually identified by number, beginning in the spring. The current names, of Babylonian origin, were adopted in antiquity. One can find both styles used throughout history.

Since the Middle Ages, the year number has almost always been *Anno Mundi,* starting with year 1 A.M. which began on October 7, 3761 B.C.E. (Julian). The historical use of several other "eras

of creation" has created much confusion, notably with regard to the date of destruction of the Second Temple in 70 C.E. Yemenites continued to use the Seleucid Era until their *aliyah*.

When written in Hebrew numerals, year numbers usually omit the millennium. Occasionally, the year number is indicated by dotted or enlarged letters that add up, numerologically (*gematria*), to the year number.

Letters and epitaphs sometimes refer to the weekly Torah reading, or quote verses from the Torah or prophetic portion. Spier, the *Judaica*, and most Hebrew-calendar software provide the necessary data for decipherment.

## 4. The Islamic Calendar

The Islamic calendar is a strictly lunar calendar, with no intercalation of months. Its independence of the solar cycle means that its months do not occur in fixed seasons, but migrate through the solar year. As on the Hebrew calendar, days begin at sunset. Virtually all Moslems follow an observation-based calendar computed, by the majority of the Moslem world, starting at sunset of Thursday, July 15, 622 C.E. (Julian); days begin at sunset and new months begin when witnesses sight the new lunar crescent, so computations are inevitably just (close) approximations to actual practice.

## 5. Pitfalls to Avoid

Early releases of the original spreadsheet program Lotus 1-2-3® treated 2000 as a nonleap year—a problem eventually fixed. However, all releases of Lotus 1-2-3® take 1900 as a leap year, which is a serious problem with historical data. Excel®, part of Microsoft Office®, suffers from the same flaw.

Days on the Hebrew calendar begin at sunset, but secular days begin at midnight. Thus determining the proper date for births and deaths requires knowing both the time of day (and local method of time measurement), as well as the specific location of the event; without such details, one can only approximate the correct date to within one day.

One common misconception regarding the Hebrew calendar is that the correspondence with the Gregorian calendar repeats every 19 years. For example, the Diaspora Museum's website (www.bh.org.il/Names/FAQ.asp#13) states the following:

> Open the Index volume of the *Encyclopedia Judaica,* p. 109, to find out converting tables of Hebrew and Gregorian dates for the years 1920 through 2020. If you look for a year beyond the period covered by those tables, do not worry. Hebrew dates coincide with Gregorian dates every 19 years. For instance: do you want to know which Gregorian date corresponds with Tishrei 12 of the year 1900? Look what was

> the Gregorian date for Tishrei 12 in 1938 (19 x 2) or any other multiple of 19 and you will discover.

This, however, is usually not the case because of the irregular Gregorian leap-year rule and the irregular applicability of the delays. In fact, Tishrei 12 in 1938 fell on October 7, while in 1900 it was on October 5.

Nor does the Hebrew calendar repeat its pattern every 247 years (the so-called "Calendar Round of Nahshon Gaon"). In the 17th century, Hezekiah ben David da Silva of Jerusalem complained about such published tables for the Hebrew calendar:

> I have seen disaster and scandal [on the part] of some intercalators who are of the opinion that the character [of years] repeats every thirteen cycles. For the sake of God, do not rely and do not lean on them. "Far be it from thee to do after this manner," which will—perish the thought—cause the holy and awesome fast to be nullified, leaven to be eaten on Passover, and the holidays to be desecrated. Therefore, you the reader, "Hearken now unto my voice, I will give thee counsel, and God be with thee." Be cautious and careful lest you forget... what I am writing regarding this matter, since it is done according to exact arithmetic, "divided well," and is precise on all counts... from the 278th cycle [1521 C.E.] until the end of time. "Anyone who separates from it, it is as if he separates [himself] from life [itself]."

By the "character" of a year, da Silva means the day of the week of New Year and the length of the year. In fact, the Hebrew calendar repeats only after 689,472 years, as was pointed out by the celebrated Persian Moslem writer, al-Biruni, in 1000.

The dates of Jewish holidays also suffer from frequent errors. For example, the United States Naval Observatory's web site had (until they were recently informed) incorrect dates for Passover in the years 2028 and 2029 (April 9 and March 29, instead of April 11 and March 31, respectively).

The correct use of the well-known formula by Gauss for the date of the first day of Passover requires high precision calculations, so it is difficult to use correctly.

## 6. Resources

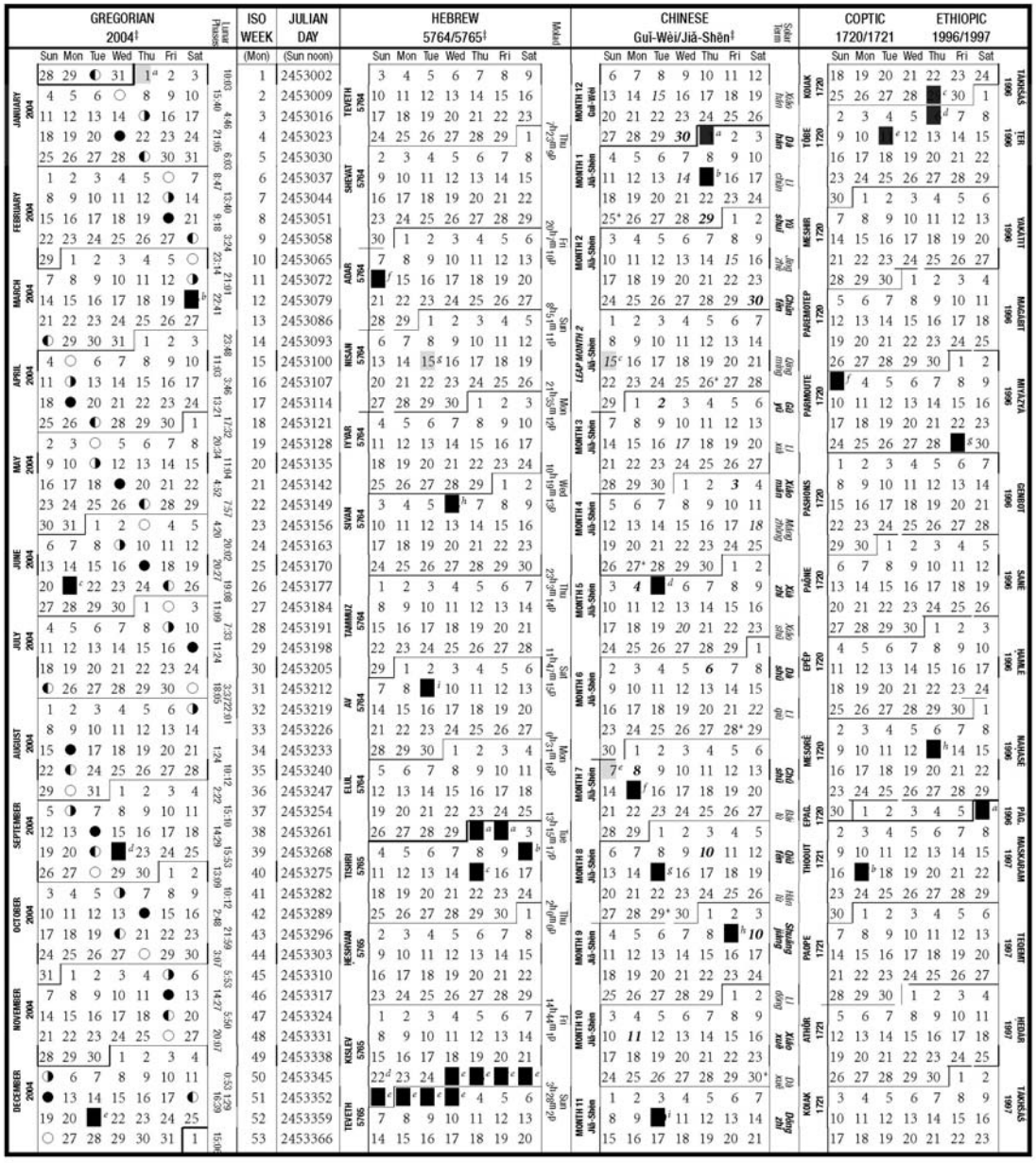
### *Books*

The most comprehensive and easily available modern reference book is

> *Calendrical Tabulations, 1900-2200,* Edward M. Reingold and Nachum Dershowitz, Cambridge: Cambridge University Press, 2002.

This book (see Fig. 1) gives a set of fully accurate, easy-to-use tables that simultaneously display the date on different calendars over a 300-year period. Included are the Gregorian, Julian,

# 2004



†Leap year
[a]New Year
[b]Spring (6:48)
[c]Summer (0:57)
[d]Autumn (16:30)
[e]Winter (12:41)
● New moon
◐ First quarter moon
○ Full moon
◑ Last quarter moon

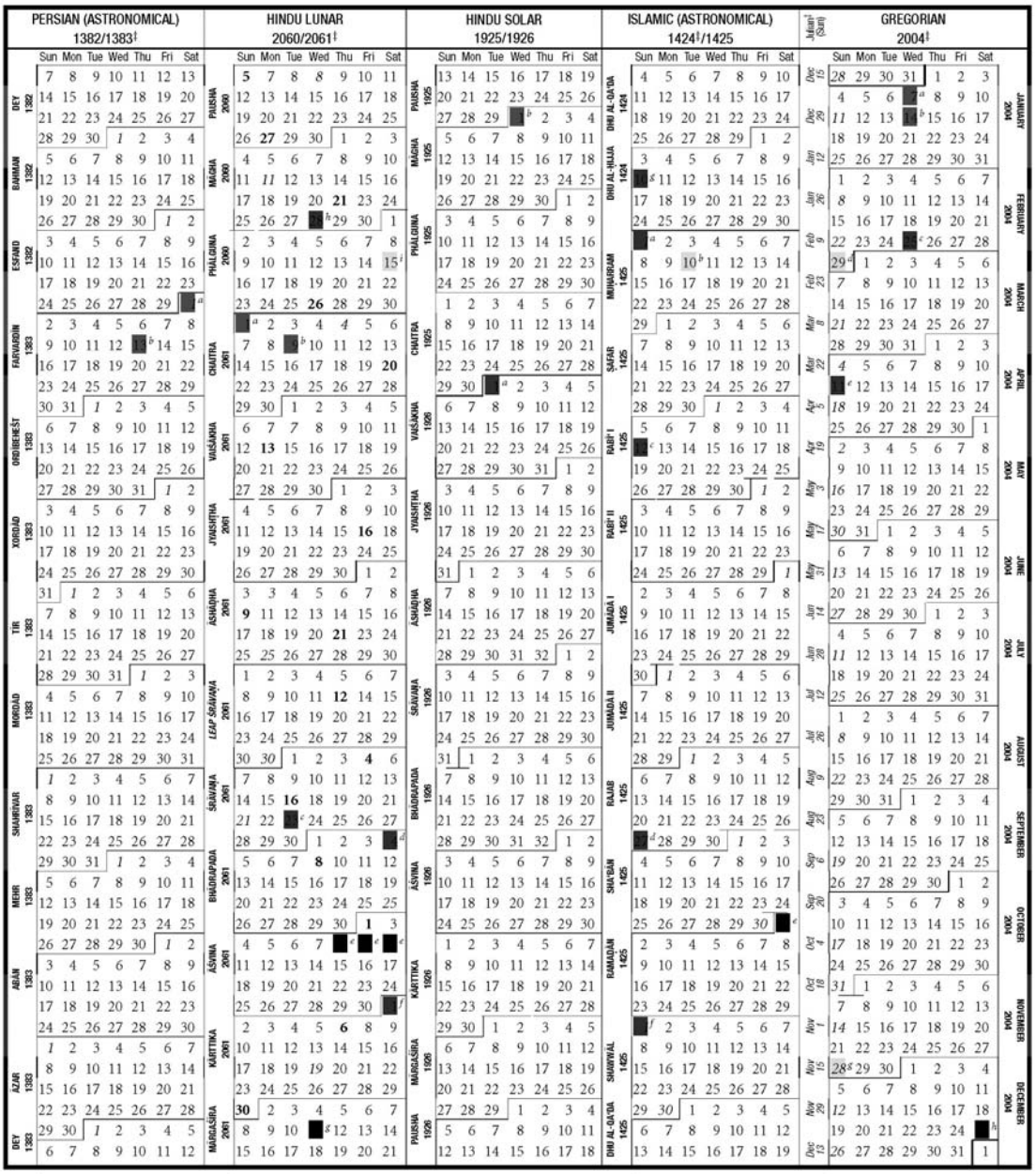
†Leap year
[a]New Year
[b]Yom Kippur
[c]Sukkot
[d]Winter starts
[e]Ḥanukkah
[f]Purim
[g]Passover
[h]Shavuot
[i]Fast of Av

†Leap year
[a]New Year (4702, Monkey)
[b]Lantern Festival
[c]Qingming
[d]Dragon Festival
[e]Qiqiǎo
[f]Hungry Ghosts
[g]Mid-Autumn Festival
[h]Double-Ninth Festival
[i]Dōngzhì
*Start of 60-name cycle

[a]New Year
[b]Building of the Cross
[c]Christmas
[d]Jesus's Circumcision
[e]Epiphany
[f]Easter
[g]Mary's Announcement
[h]Jesus's Transfiguration



**Fig. 1a.** Verso page from Reingold and Dershowitz's *Calendrical Tabulations.*




‡Leap year
[a]New Year
[b]Sizdeh Bedar

‡Leap year
[a]New Year (Tāraṇa)
[b]Birthday of Rāma
[c]Birthday of Krishna
[d]Ganēśa Chaturthī
[e]Dashara
[f]Dīwali
[g]Birthday of Vishnu
[h]Night of Śiva
[i]Holi

[a]New Year (Hemalamba)
[b]Pongal

‡Leap year
[a]New Year
[b]'Ashūrā'
[c]Prophet's Birthday
[d]Ascent of the Prophet
[e]Start of Ramaḍān
[f]'Id al-Fiṭr
[g]'Id al-'Aḍḥā

‡Leap year
[a]Orthodox Christmas
[b]Julian New Year
[c]Ash Wednesday
[d]Feast of Orthodoxy
[e]Easter (also Orthodox)
[g]Advent
[h]Christmas



**Fig. 1b.** Recto page from Reingold and Dershowitz's *Calendrical Tabulations.*

Hebrew, Chinese, Coptic, Ethiopic, Persian, Hindu lunar, Hindu solar, and Islamic calendars, as well as the phases of the moon, dates of solstices and equinoxes, and religious and other special holidays for all the calendars shown.

*Calendrical Tabulations* is based on algorithms from

> *Calendrical Calculations: The Millennium Edition,* Edward M. Reingold and Nachum Dershowitz, Cambridge: Cambridge University Press, 2001.

This book gives precise algorithmic (very technical) treatments of most of the major calendars of the world, as well as a great deal of historical material.

A standard work for converting dates between the Gregorian and Hebrew calendars is

> *The Comprehensive Hebrew Calendar: Its Structure, History and One Hundred Years of Corresponding Dates 5660-5760, 1900-2000,* Arthur Spier, New York: Behrman House, 1952; 4th revised ed., *The Comprehensive Hebrew Calendar: Twentieth to Twenty Second Century,* with preface and extended tables by H. Mandelbaum, New York: Feldheim Publishers, 1987,

which has tables for the 20th and 21st centuries (in the latest editions). Sabbath Torah readings and holidays are noted. The book includes detailed rules (corrected in the third edition) for determining Hebrew birthdays and for *yahrzeit* according to prevalent Ashkenazic practice.

The index volume of

> *Encyclopaedia Judaica,* Cecil Roth, ed., New York: Macmillan, 1971

contains a somewhat awkward calendar for the years 1920-2020, arranged by Gregorian year. The corresponding Hebrew date is given for each Gregorian day. Dates of all holidays and fasts (and an indication of postponement, if any), as well as the Sabbath readings for the Diaspora, are included.

The most highly-regarded scholarly tables are those in

> *Kalendariographische und chronologische Tafeln,* Robert G. Schram, J. C. Hinrichs'sche Buchhandlung, Leipzig, 1908.

It covers all calendars of significance for dates from thousands of years ago until 2000. (See Fig. 2.) However, this volume is rare, awkward to use, and requires some knowledge of German.

The most ubiquitous set of calendar tables is

> *The Book of Calendars,* F. Parise, ed., Facts on File, New York, 1982,

but this book is so filled with errors as to be useless.

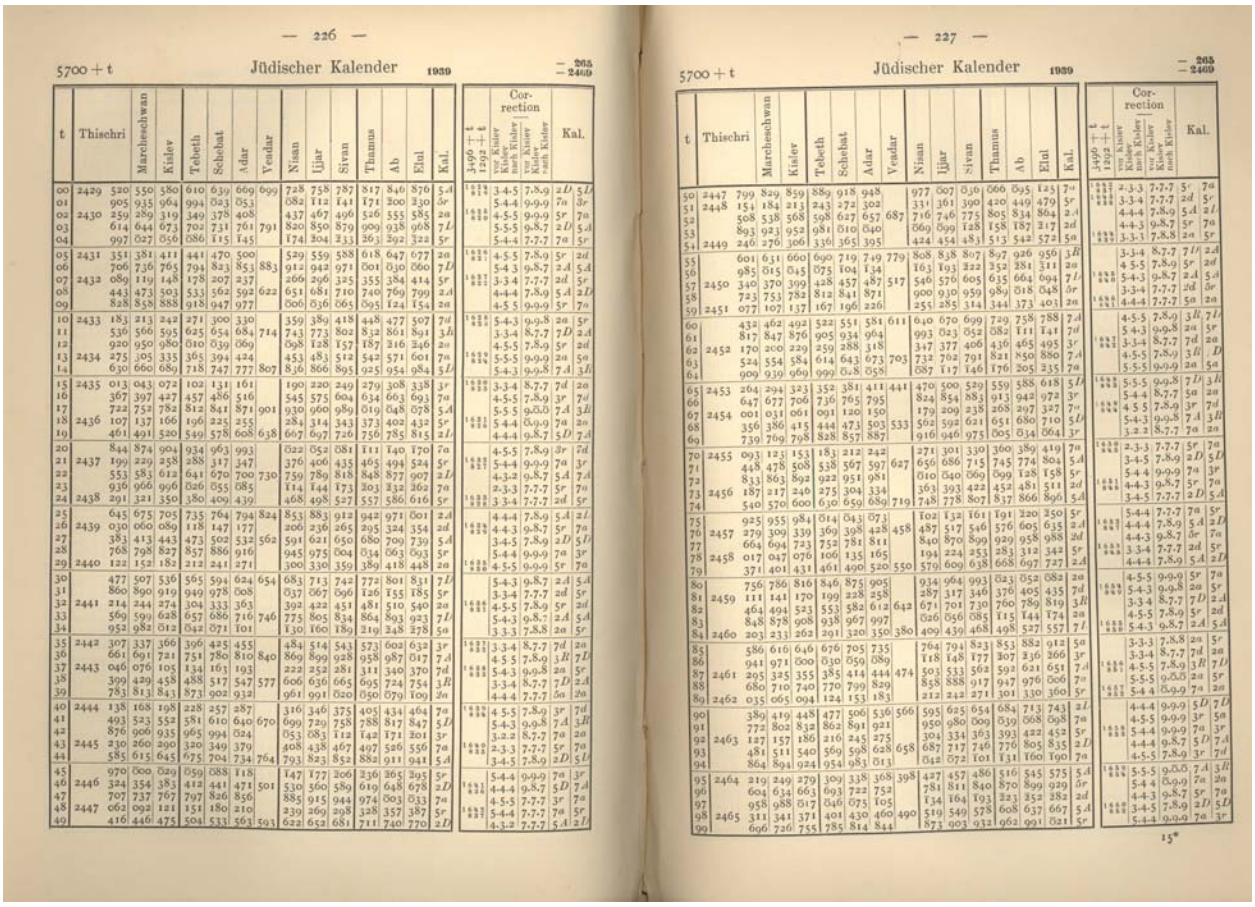


**Fig. 2.** Facing pages from Schram's *Kalendariographische und chronologische Tafeln.*

Determining the time of sunset (which is needed for ascertaining precise Hebrew dates) can be daunting. The most useful reference in this context is

> *Halachic Times for Home and Travel,* Leo Levi, Rubin Mass, Ltd., Jerusalem, 1992; expanded 3rd ed., 2000.

This book gives tables for each degree of latitude and for 73 cities with large Jewish populations. Unlike most published tables, which use mean values for dawn regardless of season or location, the times in this work are derived from astronomical calculations of the depression angle of the sun. The English section of the book also includes a short chapter on the calendar and tables that allow conversion between Gregorian and Hebrew dates. It should be noted that there remain disputes where to place the dateline for the religious purposes and what times to use in polar regions. In practice, the international dateline is used and the times of prayer and observance at nearby synagogues below the Arctic Circle are followed.

Interpreting recorded times of day also requires knowing detail of local time zone practice. The best source for historical time zones is the pair of books:

*The American Atlas: U.S. Longitudes & Latitudes Time Changes and Time Zones,* 5th ed., Thomas G. Shanks, ACS Publications, San Diego, CA, 1996;

*The International Atlas: World Longitudes & Latitudes Time Changes and Time Zones,* 5th ed., Thomas G. Shanks, ACS Publications, San Diego, CA, 1999.

These books contain extensive longitude and latitude values for locations throughout the world (needed for sunset calculations).

For dates of changeover from the Julian to the Gregorian calendar, see

*Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac,* Her Majesty's Stationery Office, London, 1961.

### *Software*

There are numerous programs available over the Internet for date conversion. The most extensive and accurate is **Calendrica**, available at www.calendarists.com. This software package is based on the algorithms of *Calendrical Calculations.* An applet for easy conversion among more than two dozen calendars is available online (see Fig. 3).

The best PC-based Hebrew calendar software is Joe Kohn's **Hebrew Calendar**, available from www.calendarmaven.com for a nominal charge. It includes a full Hebrew/Gregorian calendar (for 1600-2200), all Jewish holidays, and extensive time-of-day calculations for dawn, sunrise, sunset, candle lighting, dusk, and so on. (See Fig. 4.)

Software is also available for the Macintosh®, such as the **Jewish Calendar** by Avi Drissman.

Cumberland Family Software's **Universal Calendar Calculator** for Windows (available on the Internet at no charge) performs conversions between a large selection of calendars. (See Fig. 5.) It also contains dates of United States, Christian (Nicæan Rule and Modern), Islamic, Jewish, and Chinese holidays and is part of their genealogical software package.

The latter two programs are based on our algorithms.

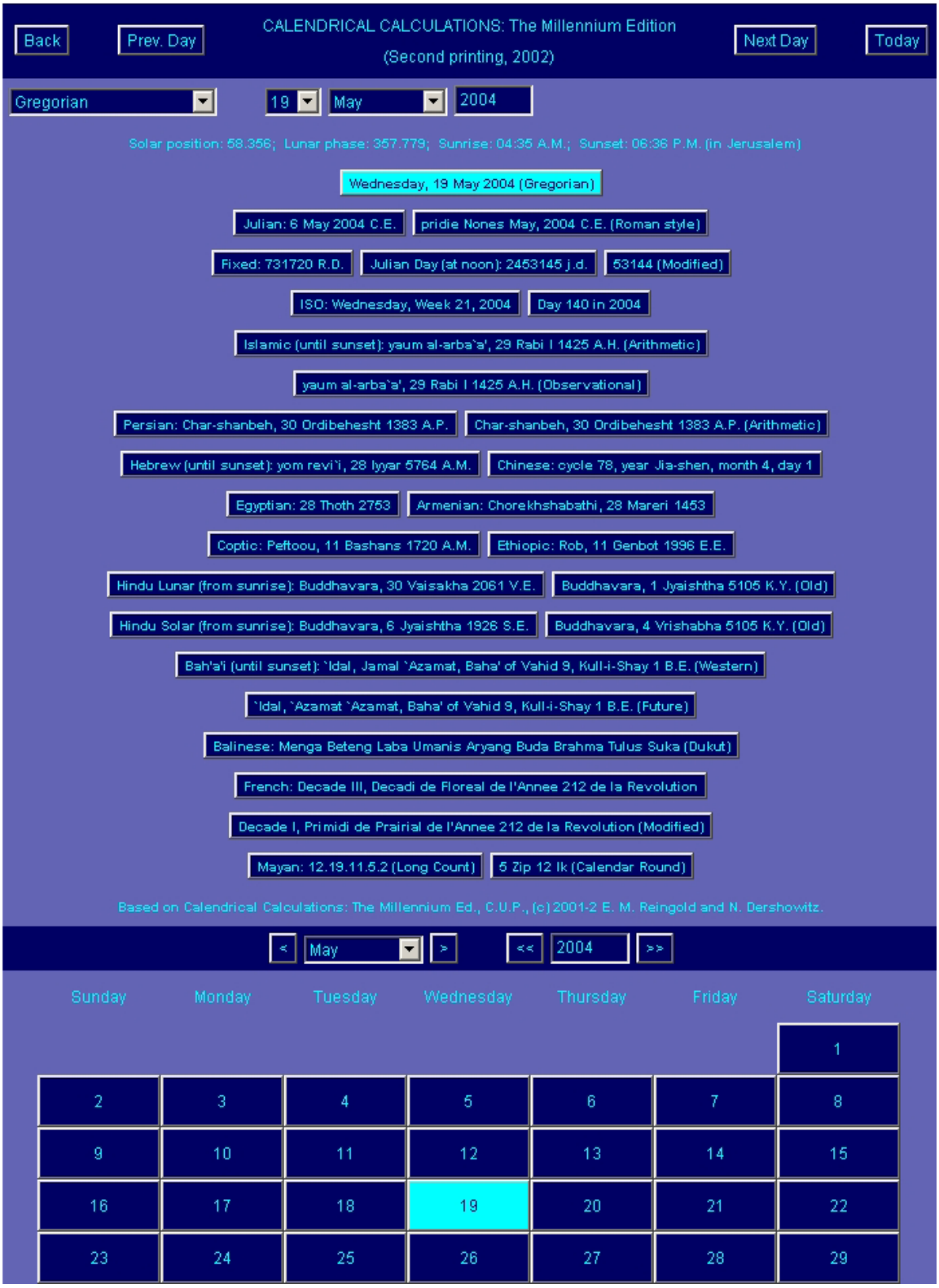



**Fig. 3.** Screenshot of **Calendrica** applet.

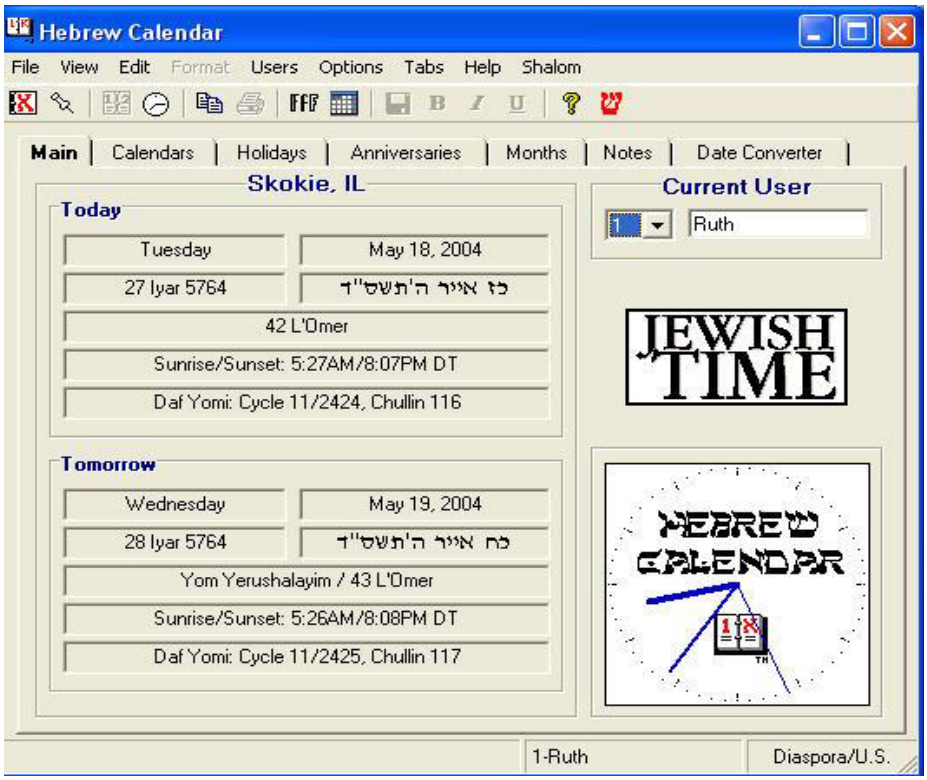



**Fig. 4.** Screenshot of **Hebrew Calendar** software.

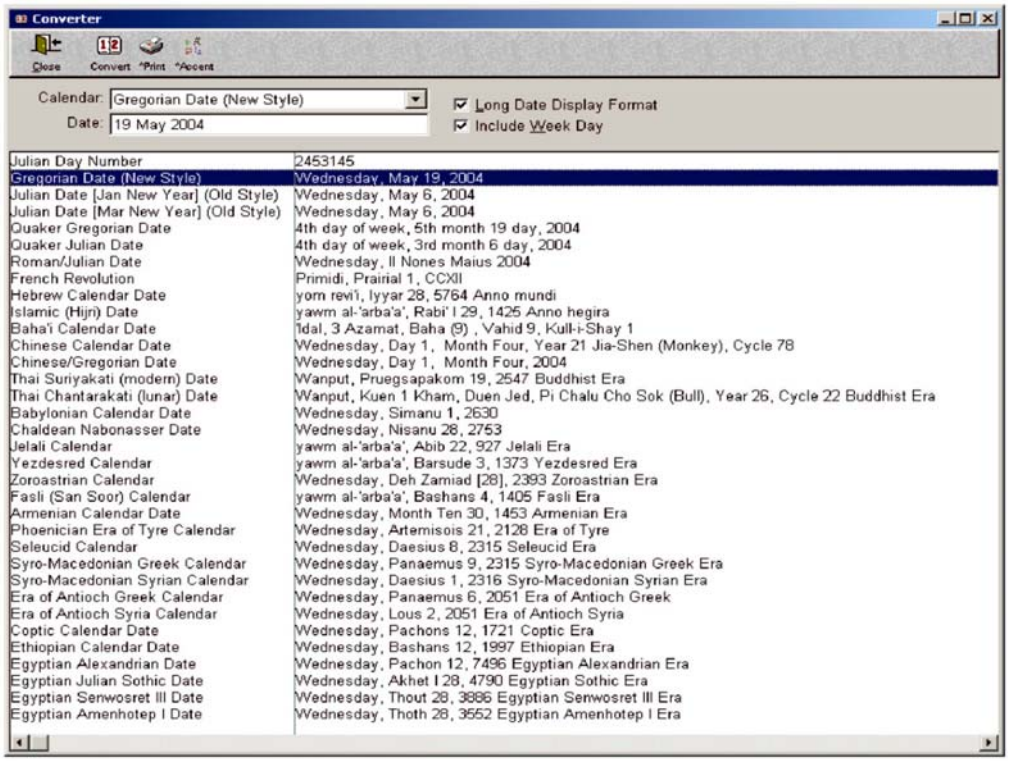



**Fig. 5.** Screenshot of **Universal Calendar Calculator**.