

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 $3\frac{1}{3}$ s 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 (19×2) 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

	GREGORIAN 2004 ¹							ISO WEEK (Mon)	JULIAN DAY (Sun noon)	HEBREW 5764/5765 ¹							MADRI	CHINESE Guǒ-Wèi/Jiǎ-Shèn ¹							COPTIC 1720/1721							ETHIOPIC 1996/1997						
	Sun	Mon	Tue	Wed	Thu	Fri	Sat			Sun	Mon	Tue	Wed	Thu	Fri	Sat		Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat
JANUARY 2004	28	29	30	31	1 ^a	2	3		1	2	3	4	5	6	7	8	9		6	7	8	9	10	11	12		18	19	20	21	22	23	24		1			
FEBRUARY 2004	4	5	6	7	8	9	10		2	3	4	5	6	7	8	9	10		13	14	15	16	17	18	19		25	26	27	28	29	30	31		2			
MARCH 2004	11	12	13	14	15	16	17		3	4	5	6	7	8	9	10		4	5	6	7	8	9	10		16	17	18	19	20	21	22	23		7			
APRIL 2004	18	19	20	21	22	23	24		4	5	6	7	8	9	10		11	12	13	14	15	16	17	18	19		23	24	25	26	27	28	29		8			
MAY 2004	25	26	27	28	29	30	31		5	6	7	8	9	10		11	12	13	14	15	16	17	18	19	20		30	1	2	3	4	5	6		9			
JUNE 2004	1	2	3	4	5	6	7		6	7	8	9	10	11		12	13	14	15	16	17	18	19	20		7	8	9	10	11	12	13		10				
JULY 2004	8	9	10	11	12	13	14		7	8	9	10	11	12	13		14	15	16	17	18	19	20	21	22		14	15	16	17	18	19	20		13			
AUGUST 2004	15	16	17	18	19	20	21		8	9	10	11	12	13	14		15	16	17	18	19	20	21	22	23		21	22	23	24	25	26	27		12			
SEPTEMBER 2004	22	23	24	25	26	27	28		9	10	11	12	13	14	15		16	17	18	19	20	21	22	23	24		28	29	30	1	2	3	4		11			
OCTOBER 2004	29	30	31	1	2	3	4		10	11	12	13	14	15	16		17	18	19	20	21	22	23	24	25		5	6	7	8	9	10	11		14			
NOVEMBER 2004	6	7	8	9	10	11	12		11	12	13	14	15	16	17		18	19	20	21	22	23	24	25	26		12	13	14	15	16	17	18		15			
DECEMBER 2004	13	14	15	16	17	18	19		12	13	14	15	16	17	18		19	20	21	22	23	24	25	26	27		19	20	21	22	23	24	25		16			
	20	21	22	23	24	25	26		13	14	15	16	17	18	19		20	21	22	23	24	25	26	27	28		26	27	28	29	30	31		1				
	27	28	29	30	31	1	2		14	15	16	17	18	19	20		21	22	23	24	25	26	27	28	29		1	2	3	4	5	6						

¹ 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

¹ Leap year
^a New Year
^b Yom Kippur
^c Sukkot
^d Winter starts
^e Hanukkah
^f Purim
^g Passover
^h Shavuot
ⁱ Fast of Av

¹ Leap year
^a New Year (4702, Monkey)
^b Lantern Festival
^c Qingming
^d Dragon Festival
^e Qiqiao
^f Hungry Ghosts
^g Mid-Autumn Festival
^h Double-Ninth Festival
ⁱ Dongzhi
^j 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*.

	PERSIAN (ASTRONOMICAL) 1382/1383 ¹							HINDU LUNAR 2060/2061 ¹							HINDU SOLAR 1925/1926							ISLAMIC (ASTRONOMICAL) 1424 ¹ /1425							GREGORIAN 2004 ¹						
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat
BEY 1382	7	8	9	10	11	12	13	5	7	8	8	9	10	11	13	14	15	16	17	18	19	4	5	6	7	8	9	10	28	29	30	31	1	2	3
BANMAN 1382	14	15	16	17	18	19	20	12	13	14	15	16	17	18	20	21	22	23	24	25	26	11	12	13	14	15	16	17	11	12	13	14	15	16	17
ESFARID 1382	21	22	23	24	25	26	27	19	20	21	22	23	24	25	27	28	29	^b 2	3	4	18	19	20	21	22	23	24	11	12	13	^b 15	16	17	18	
FAVARIDIN 1383	28	29	30	¹ 1	2	3	4	26	27	29	30	¹ 1	2	3	5	6	7	8	9	10	11	25	26	27	28	29	¹ 1	2	18	19	20	21	22	23	24
ORDBEHREST 1383	5	6	7	8	9	10	11	4	5	6	7	8	9	10	12	13	14	15	16	17	18	3	4	5	6	7	8	9	25	26	27	28	29	30	31
XORDAD 1383	12	13	14	15	16	17	18	11	11	12	13	14	15	16	19	20	21	22	23	24	25	^d 11	12	13	14	15	16	17	1	2	3	4	5	6	7
TIR 1383	19	20	21	22	23	24	25	17	18	19	20	²¹ 21	23	24	26	27	28	29	30	¹ 1	17	18	19	20	21	22	23	8	9	10	11	12	13	14	
MORDAD 1383	26	27	28	29	30	¹ 1	2	25	26	27	^b 29	30	¹ 1	3	4	5	6	7	8	9	24	25	26	27	28	29	30	15	16	17	18	19	20	21	
SHAHRVAR 1383	3	4	5	6	7	8	9	23	24	25	26	28	29	30	10	11	12	13	14	15	16	^e 2	3	4	5	6	7	8	22	23	24	^c 26	27	28	29
MEHR 1383	10	11	12	13	14	15	16	14	15	16	17	18	19	²⁰ 20	17	18	19	20	21	22	23	8	9	¹⁰ 10	11	12	13	14	29	¹ 1	2	3	4	5	6
ABAN 1383	17	18	19	20	21	22	23	6	7	7	8	9	10	11	24	25	26	27	28	29	30	15	16	17	18	19	20	21	7	8	9	10	11	12	13
AZAR 1383	24	25	26	27	28	29	30	13	14	15	16	17	18	19	1	2	3	4	5	6	7	22	23	24	25	26	27	28	14	15	16	17	18	19	20
BEY 1383	1	2	3	4	5	6	7	22	23	24	25	26	27	28	8	9	10	11	12	13	14	29	³⁰ 30	¹ 1	2	3	4	5	21	22	23	24	25	26	27
	8	9	10	11	12	13	14	29	30	¹ 1	2	3	4	5	15	16	17	18	19	20	21	6	7	8	9	10	11	12	18	19	20	21	22	23	24
	15	16	17	18	19	20	21	26	27	28	29	30	¹ 1	22	23	24	25	26	27	28	13	14	15	16	17	18	19	25	26	27	28	29	30	31	
	22	23	24	25	26	27	28	3	4	5	6	7	8	9	9	10	11	12	13	14	15	2	3	4	5	6	7	8	1	2	3	4	5	6	7
	29	30	¹ 1	2	3	4	5	10	11	12	13	14	15	16	16	17	18	19	20	21	22	11	12	13	14	15	16	17	8	9	10	11	12	13	14
	6	7	8	9	10	11	12	17	18	19	20	21	22	23	23	24	25	26	27	28	29	18	19	20	21	22	23	24	15	16	17	18	19	20	21

¹Leap year
²New Year
³Sizdeh Bedar
⁴Leap year
⁵New Year (Taraṇa)
⁶Birthday of Rāma
⁷Birthday of Krishna
⁸Ganeśa Chaturthi
⁹Dashara
¹⁰Diwali
¹¹Birthday of Vishnu
¹²Night of Siva
¹³Holi
¹⁴New Year (Hemalamba)
¹⁵Pongal
¹⁶Leap year
¹⁷New Year
¹⁸Ashūra
¹⁹Prophet's Birthday
²⁰Ascend of the Prophet
²¹Start of Ramaḍān
²²Id al-Fīṭr
²³Id al-'Aḍḥā
²⁴Leap year
²⁵Orthodox Christmas
²⁶Julian New Year
²⁷Ash Wednesday
²⁸Easter of Orthodoxy
²⁹Easter (also Orthodox)
³⁰Advent
³¹Christmas

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.

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5700 + t Jüdischer Kalender 1930 — 2400

t	Thischri	Marecheshwan	Kislev	Tebeth	Schebat	Adar	Nissan	Ijar	Sivan	Thammus	Ab	Eul	Kal.	Cor-rection	
00	2429	520	550	580	610	630	660	690	728	758	787	817	846	870	5.4
01	905	935	964	994	1023	1053	1082	1112	1141	1171	1200	1230	1260	1290	5.4
02	2430	259	289	319	349	378	408	437	467	496	526	555	585	614	5.4
03	614	644	673	702	731	761	791	820	850	879	909	938	968	997	5.4
04	997	1027	1056	1086	1115	1145	1174	1204	1233	1263	1292	1322	1351	1381	5.4
05	2431	351	381	411	441	470	500	529	559	588	618	647	677	706	5.4
06	706	736	765	794	823	853	883	912	942	971	1001	1030	1060	1089	5.4
07	2432	089	119	148	178	207	237	266	296	325	355	384	414	443	5.4
08	443	473	503	533	562	592	622	651	681	710	740	769	799	828	5.4
09	828	858	888	918	947	977	1006	1036	1065	1095	1124	1154	1184	1213	5.4
10	2433	183	213	243	272	302	331	360	390	419	448	477	507	536	5.4
11	536	566	595	625	654	684	714	743	773	802	832	861	891	920	5.4
12	920	950	980	1010	1040	1070	1100	1130	1160	1190	1220	1250	1280	1310	5.4
13	2434	275	305	335	365	394	424	453	483	512	542	571	601	630	5.4
14	630	660	690	720	750	780	810	840	870	900	930	960	990	1020	5.4
15	2435	013	043	072	102	131	161	190	220	249	279	308	338	367	5.4
16	367	397	427	457	486	516	545	575	604	634	663	693	722	752	5.4
17	722	752	782	812	841	871	901	930	960	990	1020	1050	1080	1110	5.4
18	2436	107	137	166	196	225	255	284	314	343	373	402	432	461	5.4
19	461	491	520	550	579	609	638	667	697	726	756	785	815	844	5.4
20	844	874	904	934	963	993	1022	1052	1081	1111	1140	1170	1200	1229	5.4
21	2437	199	229	258	288	317	347	376	406	435	465	494	524	553	5.4
22	553	583	612	642	671	700	730	759	789	818	848	877	907	936	5.4
23	936	966	996	1026	1056	1086	1116	1146	1176	1206	1236	1266	1296	1326	5.4
24	2438	291	321	350	380	409	439	468	498	527	557	586	616	645	5.4
25	645	675	705	735	764	794	824	853	883	912	942	971	1001	1030	5.4
26	2439	010	040	070	100	130	160	190	220	250	280	310	340	370	5.4
27	383	413	443	473	502	532	562	591	621	650	680	709	739	768	5.4
28	768	798	827	857	886	916	945	975	1004	1034	1063	1093	1122	1152	5.4
29	2440	122	152	182	212	241	271	300	330	359	389	418	448	477	5.4
30	477	507	536	566	595	625	654	683	713	742	772	801	831	860	5.4
31	860	890	920	950	980	1010	1040	1070	1100	1130	1160	1190	1220	1250	5.4
32	2441	214	244	274	304	333	363	392	422	451	481	510	540	569	5.4
33	569	599	628	657	687	716	746	775	805	834	864	893	923	952	5.4
34	952	982	1012	1042	1071	1101	1130	1160	1190	1220	1250	1280	1310	1340	5.4
35	2442	307	337	366	396	425	455	484	514	543	573	602	632	661	5.4
36	661	691	721	751	780	810	840	869	899	928	958	987	1017	1046	5.4
37	2443	046	076	106	136	166	196	225	255	285	314	344	374	403	5.4
38	399	429	458	488	517	547	577	606	636	665	695	724	754	783	5.4
39	783	813	843	873	902	932	961	991	1020	1050	1080	1110	1140	1170	5.4
40	2444	138	168	198	228	257	287	316	346	375	405	434	464	493	5.4
41	493	523	553	583	612	642	672	701	731	760	790	819	849	878	5.4
42	876	906	935	965	994	1024	1054	1083	1113	1142	1172	1201	1231	1260	5.4
43	2445	230	260	290	320	350	380	409	439	468	497	527	556	586	5.4
44	585	615	645	675	704	734	764	793	823	852	882	911	941	970	5.4
45	970	1000	1030	1060	1090	1120	1150	1180	1210	1240	1270	1300	1330	1360	5.4
46	2446	324	354	384	414	444	474	503	533	562	592	621	651	680	5.4
47	707	737	767	797	826	856	885	915	944	974	1003	1033	1062	1092	5.4
48	2447	062	092	121	151	181	210	239	269	298	328	357	387	416	5.4
49	416	446	475	504	534	563	593	622	652	681	711	740	770	800	5.4

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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.

CALENDRIAL CALCULATIONS: The Millennium Edition
(Second printing, 2002)

Gregorian

Solar position: 68.366; Lunar phase: 357.779; Sunrise: 04:35 A.M.; Sunset: 06:36 P.M. (in Jerusalem)

Wednesday, 19 May 2004 (Gregorian)

Based on Calendrical Calculations: The Millennium Ed., C.U.P., (c) 2001-2 E. M. Reingold and N. Dershowitz.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

Fig. 3. Screenshot of Calendrica applet.

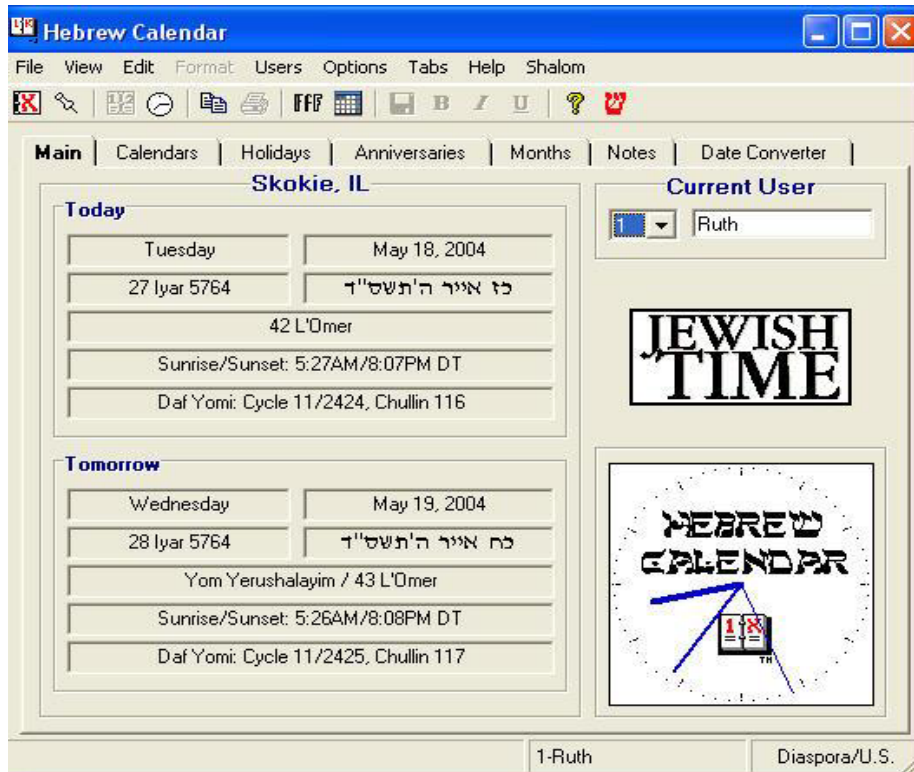


Fig. 4. Screenshot of Hebrew Calendar software.

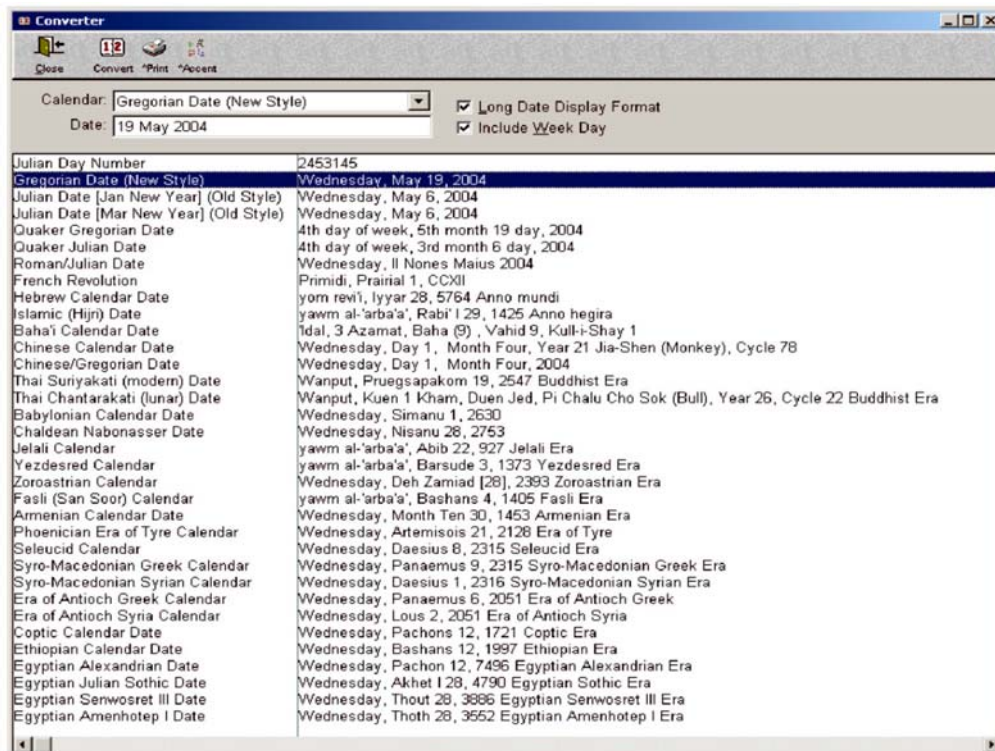


Fig. 5. Screenshot of Universal Calendar Calculator.