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A HISTORY OF CHRONOLOGY AND CALENDARS IN IRAN FROM ANCIENT TO MODERN TIMES, WITH PRINCIPLES OF DATE-CONVERSION

Reza Abdollahy

Thesis submitted for the Degree of Doctor of Philosophy to the Faculty of Arts of the University of Durham, on the basis of research conducted within the School of Oriental Studies

Submitted 1977

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To my wife
for her
infinite encouragement
and patience

ABSTRACT

The earliest Iranian dated-documents suggest that the first calendar used by the Achaemenids was the Babylonian lunisolar calendar in combination with regnal-year reckoning. The fall of the Achaemenid dynasty through Alexander's conquest, and the establishment of the Seleucid dynasty, introduced the Macedonian lunisolar calendar to Iran.

The Arsacids subsequently employed the same lunisolar Macedonian calendar with both the Seleucid and their own (Arsacid) era; during the same period, Arsacids in certain regions used the Zoroastrian calendar combined with their own era.

The Zoroastrian calendar later became the official administrative calendar of the Sasanian monarchs, with regnal-year reckoning, as practised during the Achaemenid period. The official calendar was later modified to its "Kharājī" form, while the original Zoroastrian calendar (Vahījakīk) continued to be used simultaneously for religious purposes.

The Arabian lunar-calendar enjoyed common use as a result of the Arab conquest of Iran. During the post-Islamic period, in addition to the Arabian lunar-calendar, reckoning the years from the Hijrī era, other calendars were in use at various times. The Seleucid era with Syrian months and in Julian-calendar form, and the modified Zoroastrian calendar with the era of the accession of Yazdgird III, have survived up to the present day. The same calendar, but with the era of the decease of Yazdgird III or the Kharājī era (A.D.611), was in use for several centuries. The Zoroastrian calendar of the post-Islamic period differs from that of the Sasanian period only in the omission of the intercalation of one month in every 120 years. cf p. 89

The Jalālī calendar with scientifically-based intercalation was established in A.H.471 (A.D.1079). (The duodecennial animal-cycle imported into Iran by the Mongol invasion exerted little influence). With periods of misunderstanding of its intercalation-system, the Jalālī calendar continued in use up to the present (Christian) century, during the course of which three calendars have been introduced by the Iranian Parliament. The last of these (Shāhanshāhī) is now the national Iranian calendar.

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* * *

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PREFACE

Chronology, taken in its literal etymology of "study of time", involves the investigation of methods of time-reckoning employed over the millennia in particular civilizations to locate historical events.

The degree of accuracy which can be achieved in determining the location of an event depends on the completeness of our knowledge of the elements of the calendar or calendars concerned. These elements vary greatly: they include natural phenomena, such as day and night, the moon's phases, the recurrence of the seasons, and also arbitrary man-made divisions; these two features are frequently used in combination.

Among the man-made elements of time-reckoning, two of the most-important are the "epoch" and the "era", which deserve precise definition: the epoch is the first day of a calendar; the era is the first year of a calendar. The importance of these two "landmarks" or reference-points cannot be over-stressed: since all dating depends on the precise determination of both the epoch and the era, particular attention has been devoted to this aspect in the present work.

Evidence is available relating to the epochs and eras of all but one of the thirteen calendars here discussed: the exception is the pre-Achaemenid calendar, whose very existence is called in question by the non-existence of related dates.

During the Achaemenid period, when regnal-year reckoning was practised, the epochs and the eras were as numerous as the monarchs concerned, rendering their determination accordingly more difficult. Although, with the evidence at present available, some of these regnal-year eras cannot be determined, those which are identifiable are sufficient to provide reasonably adequate reference-points for time-reckoning for this period.

In the interval of more than 550 years between the Achaemenids and Sasanids, the Seleucid and Arsacid eras were used in conjunction with a variety of calendars. Sufficient evidence is available for determination of these eras and the nature of the calendars in the present work. One of these eras (the Seleucid), with the Julian calendar and Macedonian month-names, is still used for certain purposes in Iran today. In view of this, the Seleucid era, in the form of both the Babylonian and the Macedonian calendars, is discussed at length in this work.

Regnal-year reckoning was again used during the Sasanian period, but with the Zoroastrian calendar-form, rather than the Babylonian used in the Achaemenid period. For lack of reliable evidence, only the eras of the first two Sasanian monarchs are determined in the present work. These again can serve as "stepping stones" for further time-determination in respect of this period.

The Arab invasion of Iran eventually introduced several fixed eras, some of which have already been reliably determined by eminent scholars. Additional evidence is presented here to corroborate these findings; the fixed eras which have not been determined, or which have been incorrectly determined on the basis of false hypotheses, are re-examined. Relationships established mathematically between extant dates given in accordance with these eras have been used to determine the precise locations of these fixed eras in relation to Julian dates.

Emphasis has been deliberately laid on information in the form of dates appearing in original sources and on the mathematical relationships which may be derived therefrom. In certain cases it has been possible to compensate for the scarcity of dates in documents by calling on corroborative evidence from historical or second-hand sources.

When considering calendar-information found in the works of historians and astronomers, credence is only given to their descriptions and explanations if their theories match all the available dates expressed in accordance with the calendar concerned. In the present writer's view, this must cast doubt on the more recent works, rather than on the original datings. In such cases fresh attempts have been made to determine the precise calendar-details.

For calendar-features other than the epoch and era, the Avesta, Pahlavi writings and Bīrūnī's works are regarded by all authorities as the most reliable sources for the pre-Islamic period. The Avesta, being written in a "dead" language known to few modern scholars, has of necessity been consulted in translation. To minimize the probability of errors and misinterpretation, several Persian and English translations have been examined; the evidence gleaned in this way has only been accepted where no discrepancy exists between the various independent versions. A similar procedure has been adopted in the use of other texts which could not be studied in the original.

The approach to the unique works of Bīrūnī is dichotomous: while his information on post-Islamic time-reckoning is taken almost invariably at face value, particularly when confirmed by earlier historians and astronomers, less confidence is expressed in his works relating to the pre-Islamic period. These doubts are based on the widespread contradictions and inconsistencies in his works, attributable to the considerable time-interval between that period and Bīrūnī's life-time. As in the case of the Pahlavi writings, each passage from Bīrūnī has been critically examined to determine its validity or inaccuracy. This method has on occasions confirmed the correctness of Bīrūnī's statements in the face of condemnation and misinterpretations by more-recent authors.

In the light of relevant information provided by Bīrūnī, the most important features of the Zoroastrian calendar, namely the precise date of simultaneous two-month intercalation and the method of intercalation itself, are discussed at length. The conclusions reached differ from those appearing in recent works.

The study of time-reckoning in the post-Islamic period relies heavily on so-called "zījes", i.e. astronomical tables and calendar-information in manuscript-form. Their particular importance lies in the mathematically based reliability of the incorporated date-conversion formulae. Two particular zījes have been widely consulted, since they constitute the common source of the majority of other zījes and zīj-commentaries: "Zīj-i Ilkhānī" and "Zīj-i Ulugh Beg". A third zīj, the "Zīj-i Ashrafī", has been consulted because of its perfect definitions of an even-wider range of calendars, some of which are not described elsewhere.

A source of difficulty when handling the above zījes is the widespread use of Abjad-alphabet numbering. Although Abjad numerals are familiar to most scholars, "mis-reading" has in the past led to misunderstanding of the cycle of intercalation of the Jalālī calendar.

To facilitate the extraction of information from the various zījes, the Abjad "code" has been tabulated alongside the equivalent English letters and their equivalent numbers (Tables 15 and 16).

Reference to the zījes leads naturally to the subject of footnotes and bibliography. As with any work which is better-known by its title than by the author's name, e.g. "Tārīkh-i Qum" rather than Hasan b. Muḥammad b. Ḥasan Qummī, the zījes are invariably referred to in this way; however, when a work is mentioned by its title in the text, the author's name is given in a footnote for the reader's convenience.

With this same aim of facilitating the reader's "task", the method which has been adopted is to include brief literary references in footnotes on the same page and to give more comprehensive reference-details in an alphabetically arranged bibliography at the end of the thesis. In the footnotes the author's name or the title of the work is followed by the date of publication or the relevant catalogue-number of the manuscript. In cases where more than one work has been published by the same author in the same year, the first work is referred to by the date followed by "a" and the second work by the date followed by "b". Roman numerals after a publication-date represent the volume, when two or more volumes of the work were published in the same year.

Reference-dates without a prefix or suffix, e.g. (1977), represent Christian dates. The abbreviations H.S., A.H., A.Y. and Sh. represent solar-Hijrī, lunar-Hijrī, Yazdgirdī and Shāhanshāhī dates; they imply, additionally, that the publication concerned is in Persian or Arabic. There are a few deviations from this rule in the case of works published in Persian or Arabic in Europe, for which a Christian publication-date is given; details of the associated Persian or Arabic text are given in the bibliography.

The method of transliteration of Persian words adopted is that employed in the "Cambridge History of Iran"; words for which generally accepted anglicized forms have evolved are included in their popular form, occasionally accompanied by a parenthetical strict transliteration, e.g. Koran (Qur'ān), Mecca(Mikka), etc.

The convention of underlining the titles of works has been followed in the footnotes and bibliography, but not in the text, for three reasons: (a) aesthetic appearance; (b) underlining and under-dotting already involved in many transliterated titles; (c) the alternative purpose of underlining, i.e. stress or emphasis. The titles of works named in the actual text have been indicated by quotation marks, with the exception of those sufficiently well-known to make this unnecessary, i.e. the Avesta and the Bundahishn.

Conversely, where a non-English author is known to favour a particular transliteration of his own name, his preferred version has been respected. Similarly, no modification is made to verbatim quotations contravening the above transliteration-principles.

I would like to take this opportunity of expressing my gratitude for the continued advice, encouragement, and translation of relevant literature from a variety of languages to my supervisor, Mr Frank R.C. Bagley, Lecturer in Persian at the University of Durham, without whose help this thesis could not have been produced. I would also like to record my thanks for the assistance of Mr Paul Perkins of Newcastle-upon-Tyne Polytechnic with linguistic problems, and particularly for translating passages from various European-language sources.

I owe a particular debt to Dr. G. Motamedi, former Chancellor of Isfahan University, and the present Iranian Minister of Science and Higher Education, for his continued interest and support.

I would also like to thank my colleagues at the University of Isfahan, Drs. Kamal Mūsavi, Lutfullah Honarfar, M.J. Shari'at, M.H. Karimi, J. Doostkhah and A. Agahi, for their advice and help with translation, and for transmitting relevant literature to me during my period of research in England.

I owe a particular debt to three institutions: the British Museum (Department of Oriental Printed Books and Manuscripts); the India Office Library and Records; and the Bibliothèque Nationale. All have proved exceptionally helpful on my frequent visits and in providing microfilms and photographs of relevant sources.

My thanks are also due to members of the staff of the University of Durham, too numerous to mention individually, but in particular to Miss L. Forbes and Mrs J. Butterworth of the Library of the School of Oriental Studies.

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ABBREVIATIONS

Adh.	Ādhar
A.E.	Arsacid era
A.H.	Arabian lunar-Hijrī calendar
A.J.	Jalālī calendar
A.Y.	Yazdgirdī calendar
A.20.Y.	Magian era
Bah.	Bahman
Dhu-H.	Dhu'l-Hijja
Dhu-Q.	Dhu'l-Qa'da
Far.	Farvardīn
H.S.	Solar-Hijrī calendar
Isf.	Isfand/Isfandārmadh
Jum. I	Jumādā I
Jum. II	Jumādā II
Khur.	Khurdād
Muḥ.	Muḥarram
Mur./Amur.	Murdād/Amurdād
n.s.	new-style, i.e. Gregorian
o.s.	old-style, i.e. Julian
Rab. I	Rabī' I
Rab. II	Rabī' II
Ram.	Ramaḍān
Sh.	Shāhanshāhī calendar
Shar.	Shahrīvar
Shaw.	Shawwāl
Urd.	Urdībihisht

(The remaining abbreviations used in this thesis are considered to be self-explanatory.)

CHAPTER I

Elementary principles of calendar-construction

A calendar is a man-made system of measuring time. Although the flux of time is apparently without beginning or end, it is divided by nature itself into periods, which have been adopted by Man as time-units. To these he has added time-units devised by himself. The various units used over the centuries include:

I. Alternation of day and night;

II. Months (various forms);

III. Seasons (various forms);

IV. Years (various forms);

V. Subdivision of months (various forms).

I.I. Alternation of day and night

Although most present-day calendars utilize the mean solar day, beginning at midnight, a study of ancient and mediaeval calendars necessitates an attempted definition of all kinds of nychthemera (1), which have been, or are in use, as units of time-measurement.

The alternation of day and night is the smallest and most convenient unit for measuring time; through its obvious relationship with human activities, it naturally came into universal use as the basic time-measurement unit (2). The lengths of other units, such as weeks, months, seasons and years, are expressed in numbers of days or nights (see Sections I.II to I.V).

Mankind has recognized several kinds of nychthemeron, whose length depends on different natural phenomena, e.g. the rotation of the earth on its axis and the associated sunrise in the east and sunset in the

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1. The Greeks employed the word Nychthemeron to denote the complete duration of 24 hours, comprising one day and one night, for which there is no corresponding term in English; in Persian the word "shabāna-rūz", from "shab" (night) and "rūz" (day) is used, and occasionally "shabārūz" (e.g. in the al-Tafhīm, ed. Humā'ī (1316-1318 H.S.), pp.66ff.). It was, and is, the practice to write "shabānrūz" instead of "shabāna-rūz" (e.g. in the Nawrūz-nāma, ed. Mīnovī (1312 H.S.), pp.2,5,79 and also in the Zīj-i Ulugh Beg, ed. Sédillot (1947), pp.292,293ff.). For the terms "shab" and "rūz" in old Persian, Avestic, Pahlavi, see Lughatnāma, entries rūz and shab, and Burhān-i Qāṭi' (1342 H.S.); also Mu'īn 1325 H.S., pp.12-13.

2. Olmstead (1938,a), p.114.

west, the orbital motion of the earth round the sun (1), and the orbital motion of the moon round the earth and with respect to the fixed stars; of these nychthemera, only a few have been used for calendar purposes. Moreover, at different times and places different starting points have been chosen for the nychthemeron (dawn, sunset, midnight, midday); this is important when converting dates from one calendar to another and when determining the leap days and leap years of a particular calendar. Many of the errors and misunderstandings which arise, especially in the conversion of dates and interpretation of leap-year cycles, are caused by this source of ambiguity (2).

The length of the day, even when measured by crude chronometers, was bound to be variable in length (3). It is consequently usually defined as the "Mean Solar Day", implying the average interval between the two successive transits of the sun over the same meridian. At the present day, it is calculated from a large number of observations of such meridian transits, using accurate clocks, and has been adopted as the fundamental unit of time (4).

Astronomers chose the sidereal day, which is the interval between two successive "passages" of a "fixed" star. The sidereal day is shorter than the solar day: while the earth completes one revolution on its axis, it also moves along the ecliptic around the sun; it consequently takes slightly longer for the meridian to be aligned with the sun. $365\frac{1}{4}$ mean solar days are equivalent to $366\frac{1}{4}$ sidereal days.

Since the sun crosses each meridian at a different moment of absolute time, the local mean time is dependent on longitude (5) and is defined by two consecutive passages of the centre of the "mean sun

---

1. As earth/sun relationships are relative, to avoid confusion and simplify the study of time-relationships, it is expedient to imagine the earth as stationary and the sun executing a circuit around the earth once in every 24 hours.

2. See Parker (1941), p.289, n.20.

3. Bīrūnī was aware of the variation of the length of the nychthemeron: "the nychthemera vary, and are not always the same length; a variation which, during the eclipses, is clearly apparent even to the senses. The reason of this variation is the fact that the course of the sun in the ecliptic varies, it being accelerated one time and retarded another; and that the single sections of the ecliptic cross the circles (the horizons) at a different rate of velocity" (Bīrūnī (1879) pp.6-7; (1352 H.S.), pp.8-9; (1910,I), pp.327-328).

4. The variation of the solar day arises from two factors: (a) the obliquity of the sun's path to the equator; (b) the unequal motion of the sun at different seasons of the year.

5. See Bīrūnī (1910,I), p.327.

disc"(1) across a particular meridian. In the study of ancient and mediaeval calendars, local mean time has an important bearing on calculations, because the beginning of the year and the determination of leap years depend on local mean time, as reckoned by contemporary local inhabitants.

Although there was great variety in the methods of subdividing the nychthemeron in ancient and mediaeval times (2), since about the 14th century A.D. it has for practical purposes been almost universally subdivided into 24 hours, each consisting of 60 minutes, made up of 60 seconds. This practice developed from the invention and propagation of the striking clock (3).

The method employed by the ancient Iranians to subdivide the nychthemeron during the Median and the Achaemenian periods is unknown; according to Zoroastrian sacred writings the nychthemeron was divided into five parts in summer, one of which was dropped in winter when the days were short (4). Each part was called "gāh" ("gās" in Pahlavi) (5); these were of unequal length and also varied throughout the year (6). In the Zoroastrian religion each "gāh" has its own special prayer and is associated with an angel of the same name and with other guardian angels.

The gāhs are as follows:

Hāvanī (Hāvan; Hāvangāh)

This gāh runs from sunrise till midday. Its exact starting point is unclear: according to the Bundahishn, "when it is morning then it is the Gāh Hāvan (7). Pour Davoud states that the hāvangāh starts at

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1. As has already been mentioned, the sun's motion is in fact irregular. An imaginary "mean sun" was invented to overcome this difficulty.

2. For further details see Sarton (1959), pp.331ff. and Haswell (1928), pp.2ff., Bickerman (1969),p.14.

3. Welch (1972), pp.24ff.; Sarton (1953,b,I), p.716.

4. See Bundahishn (1880), Ch.25,vs.9-10,p.94; (1956), p.207. See also Spiegel (1864), p.16; Gray (1910), p.129; Nadershah (1914), pp.286,289-290,293; Pour Davoud (1347 H.S.,I),p.30,n.2. Cf. Taqīzādeh (1317 H.S.), p.89,n.178.

5. See Mu'īn (1342-1352 H.S.), entry gāh; (1325 H.S.), p.12.

6. According to Sarton (1953,a), p.72,n.31, the use of unequal divisions of the day was almost universal in ancient times and continued in parts of Europe up to as late as the eighteenth century. See also Welch (1972), p.15.

7. See the Bundahishn (1880), Ch.25,vs.9,p.93; (1956), p.207.

sunrise (1). Gray (2) observes that the "time of preparation of Haoma" is dawn to noon (3). In Yasna IX,vs.1 and X,vs.4 (4), the beginning of this gāh is described as "the morning dawn". At the present time the Zoroastrians of Yazd (the centre of the Zoroastrian community in South-East Iran) extract the juice from the Haoma plant at dawn.

The period of Hāvanī is under the guardianship of Mīthra and two angels Sāwangahī and Wīsīya (5).

Rapīthwīn (Raftūn; Raftungāh)

This gāh lasts from midday till twilight; its guardian angels are Frādat-fshū and Zantūm (6).

Uzaya-īrin (Uzayran; Uzayrangāh)

This gāh is from twilight till the appearance of the stars. Uzaya-īrin is associated with Frādat-wīr, the preserver of mankind, and Dakhyum, the protector of the district (7). This gāh is obviously the shortest of all.

Aīwsrūthrim (Aīwathrim; Aīwathrītramgāh)

This gāh runs from the appearance of the stars till midnight. Frādat-wīspam-hūjīyaītī, the protector of all plants, and Zarathushtrūtim, the protector of priests, are associated with the angel Aīwsrūthrim, in joint guardianship of the gāh (8).

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1. Pour Davoud (1347 H.S.,I), p.30; see also Nadershah (1914), p.290.

2. Gray (1910), p.129.

3. Kuka (1900), p.60.

4. Yasna (1864), pp.50,56.

5. Darmesteter (1883), p.5; see also p.349 of same work. The angels Sāwangahī and Wīsīya also protect cattle and villages respectively; see Yasna II, (1864), v.13; III, v.69; IX, v.1; XVII, v.74; XLIII, v.5; and Spiegel (1864), Khurda-Avesta, VII,vs.1-3.

6. Frādat-fshū is associated with the fertility of cattle; Zantūm protects confederacies: see Spiegel (1864), Khurda-Avesta, XVI,2, Gāh Raftūn; and Yasna II,vs.16-18; see also Darmesteter (1883), p.5; and Kuka (1900), p.61.

7. Spiegel (1864), Khurda-Avesta XVI,p.16; and Yasna II,vs.19-22; see also Darmesteter (1883), p.6, and Pour Davoud (1347 H.S.,I), p.30.

8. Spiegel (1864), Khurda-Avesta XVI,p.16.

Ushahīn (Ushahīn; Ushahīngāh)

This gāh lasts from midnight till the disappearance of the stars. Birijya, the increaser of corn, and Nmānīya, the protector of prosperity, are associated with Ushahīn in protecting this gāh (1).

Spiegel (in a note to Yasna I,v.7,p.30) presents a different concept of the five gāhs from the above, but the above description is almost identical to Spiegel's notes to Khurda-Avesta XVI, Gāhs, p.16, and Pour Davoud's note (2). According to Spiegel's note on Yasna I, v.7, and Yasna I, vs.3-8, the gāhs do not represent periods, but merely starting points of parts of the day.

According to Gray (3), Hāvanī lasted from dawn to noon; Rapīthwīn from noon to the seemingly arbitrary hour of 3 p.m., Uzaya-irīn from 3 p.m. to twilight, Aīwsrūthrim from twilight to midnight, and Ushahīn from midnight to dawn. This subdivision differs from that of Spiegel and Pour Davoud; according to Gray, the word "Ushahīn" means "dawn"; he believes that the Hāvangāh has taken its name from the end of "Ushahīngāh".

In winter, when the days are shorter, Raftungāh was omitted, Hāvangāh being extended from dawn till the Uzayrangāh (4).

Although Bihrūz (5) describes three kinds of nychthemeron and states that the commencement of the oldest one (called Yazdgirdī (6)) was from sunrise (7), it nevertheless appears from the above and from the order of the gāhs in the Khurda-Avesta and Yasna that the nychthemeron began at dawn (8).

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1. Spiegel (1864), Khurda-Avesta, note to XVI, Gāh-Hāvan, p.16 and p.20, also Yasna II,vs.23-25. Pour Davoud (1347 H.S.,I),p.30.

2. Pour Davoud (1347 H.S.,I), p.30.

3. Gray (1910), p.129.

4. Gray (1910), p.129. See also Pour Davoud (1347 H.S.I), p.30; cf. Boyce (1970), p.513.

5. Bihrūz (1347 H.S.), p.9.

6. According to Bihrūz ((1331 H.S.), p.30), the term Yazdgirdī means "In the name of God", a title applied to special days, months and years dedicated to God.

7. The exact translation of Bihrūz' statement is: "The commencement and the end of the Yazdgirdī nychthemeron is from the time when the centre of the sun's disc is visible on the horizon of Nīmrūz" (Sīstān, a city in the East of Iran). See also Bihrūz (1331 H.S.), p.16.

8. See also Bundahishn (1956), Ch.25, v.2,p.205.

The Indo-European peoples in ancient times, like most peoples of the world, used to count the days by the nights (1), e.g. English "fortnight" and the now-obsolete "sennight". In Iran it has also been customary to use the term "shab" (night) as being synonymous with "nychthemeron" (shabāna-rūz). In Zoroastrian sacred writings, the expression equivalent to "day-and-night" (nychthemeron) is frequently used in time-measurement (2), although the words for "day" or "night" are sometimes used alone to represent nychthemeron (3). In the Vandīdād, Fargard XVI (4), dealing with the treatment and behaviour of Iranian women during periods of menstruation and childbirth, time is measured by the counting of nights. When travelling is discussed, however, time is measured in days (5).

The late S.H. Taqīzādeh (6) observed that, after the spread of the Zoroastrian religion, the night became the accepted unit of time-measurement. It is curious that the Zoroastrian sacred writings mention two thirty-day periods (sīrūza) entitled the Great and the Small Sīrūza (7), but never a Sīshaba (thirty-night period). Reckoning by the nights, traces of which are to be found in Zoroastrian writings, is probably a relic of the Achaemenian period, when the lunisolar Babylonian calendar, in which the nychthemera were reckoned by the nights (8), was still in use (see pp.10ff.). It is also possible that the practice resulted from the use of the Seleucid calendar at a later period (see pp.10ff.).

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1. Nilsson (1920), p.13; see also Taqīzādeh (1317 H.S.), pp.96-97. For Mānī's doctrine of the priority of light, see Ibn Nadīm (1970), p.777. According to Bickerman ((1969), p.13), the Celts and Germans counted nychthemera by the nights.

2. Pour Davoud (1347 H.S.,I), p.259.

3. Ibid, p.289.

4. Spiegel (1864), p.121.

5. Pour Davoud (1347 H.S.,I), pp.289, 329. See also the Bundahishn (1956), Ch.25, v.2, p.205: "one ought always to reckon the day first, then the night; for, first the day goes off, and then the night..." Ibid, Ch.30, vs.4-8 and Ch.31, v.16, pp.257, 265-267.

6. Taqīzādeh (1317 H.S.), p.96.

7. Darmesteter (1883), pp.1-21.

8. Parker and Dubberstein (1946), p.24.

Reckoning the nychthemera by the nights gradually became the practice after the appearance of Islam in Iran. Bīrūnī (A.H.362/A.D.973-A.H.440/A.D.1048)(1), one of Iran's best-known authors and foremost scientists of Islam (2), was, according to Sachau (3), "a phenomenon in the history of Eastern learning and literature". In his books al-Āthār al-Bāgīya ʿan al-Qurūn al-Khālīya (c. A.D.1000)(4), and al-Tafhīm (5), Bīrūnī explained the beginning and end of various kinds of nychthemera. His explanation of the Arabic (Islamic) nychthemeron, which was adopted by the Iranian people after their domination by Islam, is in agreement with most explanations found elsewhere. A summary of Bīrūnī's version and an account of the changes in approach over the centuries are given below.

The Moslem or "sharʿī" (religious) nychthemeron begins at the point where the whole of the sun's disc disappears beneath the horizon (6), and is divided into two twelve-hour periods, starting at that point (7). In modern times, it has become customary to start at a standard 6 p.m. (local time, European system), the two periods therefore corresponding to 6 p.m.-6 a.m. and 6 a.m.-6 p.m. (8); thus 2 o'clock in the evening means 8 p.m., and so on (9). The starting point, end and division of the religious nychthemeron were, and still

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1. For details of Bīrūnī's years of activity, see Sachau (1910,I), pp.viii, xxiv and Qazwini (1910), pp.195-198; Browne (1921), pp.127-129.

2. For authenticity of Bīrūnī, see Sarton (1953,b,I), pp.693, 707-709.

3. Sachau (1879), p.x.

4. For date of composition of this book, see Humā'ī (1316-1318 S.H.), p.(ز), i.e. D.

5. Bīrūnī wrote this book both in the Arabic and Persian Languages, calling it Kitāb al-Tafhīm li awā'il-i Sināʿat al-Tanjīm, in A.H.420/A.D.1029. Humā'ī wrote a scholarly introduction with useful annotation to the Persian version, published in 1316-1318 H.S.

6. Bīrūnī (1879), p.5; (1910,I), p.327. Cf. Zīj-i Ulugh Beg (1847), pp.292-293; Janāb (1303 H.S.), pp.90-91.

7. See Abu'l-Khayr Muḥammad Fārsī (1348-1349 H.S.), pp.49-50; Janāb (1303 H.S.), pp.90-91.

8. Janāb (1303 H.S.), pp.90-91.

9. Those employing this system, which is today called the ghurūb-kūk (i.e. "wind up at sunset") system, set their watches at 12 o'clock when it is 6 p.m. (local time, European system). Two hours later, when asked the time, they reply that it is "two hours past the handle" (on Iranian pocket-watches, twelve o'clock was marked directly below the winding spindle). Some present-day Iranian almanacs still give the local time of sunset for the main cities of Iran by the ghurūb-kūk system. See Janāb (1303 H.S.), pp.17-21.

are, a subject of controversy among astronomers and clergy (1). Bīrūnī (2) criticises those clergy who think that the beginning and the end of the day coincide with the beginning and end of fasting. Moreover, the very division of the nychthemeron into day and night has never been a unanimous practice among astronomers and clergy (3).

As mentioned above, the shar'ī nychthemeron begins at sunset; the days of the week are therefore likewise reckoned from sunset (maghrib, i.e. disappearance of sun below horizon) and extends to the same time on the following day. For this reason, the night which follows daylight on Friday is called the night of Saturday, and so on (4). The explanation is that the Moslem calendar is based on the course of the moon, and the month begins with the appearance of the crescent, which is towards sunset (see below, p.10). Bīrūnī explains the philosophers' view of the beginning of the nychthemeron, which was based on their beliefs relating to the creation of the world (5) and contemporary practices in Iran and other countries (6). The subdivision of the nychthemeron into hours and other units is described in detail in the Zīj-i Ulugh Beg (7) and al-Tafhīm (8).

Still in the same context, a special method is used to determine New Year's Day in the Jalālī (also called Malikī and Malikshāhī) calendar. This is the day on which the equinox occurs before the noon of that day and after the noon of the preceding day. New Year's Day in the Jalālī calendar is thus determined on the basis of the astronomical day, i.e. from noon to noon. This does not, however, mean that the nychthemeron begins at noon (see Chapter IV.IV).

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1. Davidian and Kennedy (1961), pp.145-153.

2. Bīrūnī (1879), pp.7-10; (1352 H.S.), pp.10-15; (1316-1318 H.S.), p.79.

3. Bīrjandī (Ethe 3000), folios 4^a-5^b.

4. The late S.A. Kasravī (1335 H.S.), pp.233-238, described the difficulties which arose from this method of counting the days.

5. Bīrūnī (1879), pp.5-6; (1352 H.S.), p.6.

6. Bīrūnī (1879), pp.6, 315; (1352 H.S.), pp.7, 435; also al-Tafhīm (1316-1318 H.S.), pp.66-69, including footnotes.

7. Zīj-i Ulugh Beg (1847), pp.293-295.

8. Bīrūnī (1316-1318 H.S.), p.70.

I.II. Months (various forms)

In most modern calendars the month is a conventional subdivision of the year; it has nothing to do with the moon or the time taken by the sun to traverse a single constellation, even though in many languages, including Persian and English, the word itself signifies "moon". In Persian this word "māh" is applied equally to the lunar, solar and conventional months, purely on the basis of the historical derivation of the "month" concept from the lunar month (1).

Many historians and scientists believe that time-measurement on the basis of the lunar phases goes back to the very infancy of mankind (2). In this connection, Bīrūnī (3) is of the view that, dating from the Deluge, it was legally permitted for the Jews to fix the beginning of the months by calculation instead of observation. He asserts that, according to Jewish belief, Noah computed and fixed the beginning of the months by calculation, because the sky was obscured by cloud for a period of six months, during which time neither new moon nor any other phase of the moon could be observed (4). The early practice of time-measurement by the phases of the moon is supported by much evidence in ancient writings and by certain ancient calendars (5). In the Avesta, "month" and "half-month" are mentioned on various occasions, but we have no definite evidence about the beginning, end, length and sub-division of the month (6) or about the usage of the lunar month as a unit of time-measurement prior to the adoption by the Iranians of Babylonian lunisolar time-reckoning (see Chapter II). The natural and conventional months, which are the basis of calendar studies, have continually been used in Iranian calendars, at least in those calendars which the Iranians adopted from other peoples.

Although the astronomical lunar months do not contain a whole number of days, the complete days only are obviously reckoned in all calendars; the "real lunar month", which was in use by many ancient civilized peoples, may be defined variously as the period from new

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1. Nilsson (1920), p.146; Meer (1955), p.1. See also Rawlinson (1879), pp.251.

2. Nilsson (1920), pp.144-149; Bickerman (1969), p.17.

3. Bīrūnī (1879), pp.67, 68; (1352 H.S.), p.87.

4. See Aid to Bible Understanding (1971), p.77. Cf. Parker and Dubberstein, (1946), p.4.

5. Bickerman, (1969), p.17.

6. Spiegel (1864), Yasna II, vs.29-35, pp.33-41, and Taqīzādeh (1317 H.S.), p.96.

moon to new moon, full moon to full moon (1), from the disappearance of the old moon just before dawn to the next disappearance of the old moon at roughly the same time (2), or from the first night the moon is not visible until this recurs (3).

The Babylonians, Jews and many other communities began their month at the first appearance of the new moon (4), as the Moslems (Muslims) still do today in their religious calendar, i.e. the month begins with the night of the first appearance of the slender crescent, the first day of their month being the succeeding day. Owing to perturbations of the moon's motion (5), such as orbital eccentricity, time of perigee and apogee, inclination of the orbital plane, as well as aphelion and perihelion of the earth at the time of conjunction, and several other variable factors (6), which have attracted astronomers' attention from early times (7), the successive months are not equal in length (8). The main problem is thus to determine which months are to be 30-day months and which 29-day. In considering this problem, it is quite possible to have two 30-day months (full months) or two 29-day months (empty months) in succession. Three successive 29-day months and three, or at times four, and very rarely five, 30-day

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1. Hindu months of the earliest times (depending on the antiquity of the Vedic writings) ran from full moon to full moon (Brennand, (1896), p.68; Report of the Calendar Reform Committee of India (1955), pp.185, 201). See also Bīrūnī, (1910,I), p.348. Cf. Encyclopaedia Britannica (15th edition), vol.III, p.607.

2. The Egyptians began their month at the disappearance of the old moon. See Parker, (1941), p.289, n.2; (1950), pp.9-10.

3. According to Nilsson ((1920), p.169), two East African tribes, the Masais and Wadshaggas, begin their month with the moon's invisibility; the day of the new moon is therefore the fourth day of their months. See also Parker, (1941), p.289, n.20; (1950), pp.9-10.

4. See Bīrūnī (1879), pp.67, 74-76; (1352 H.S.), pp.86, 94-96; (1910,I), p.348; Nilsson (1920), pp.16-20; Langdon and Fotheringham (1928), pp.46, 47, 76; Langdon, (1935), pp.54, 71; Parker and Dubberstein (1946), pp.4, 24; Neugebauer, (195?), p.41; Pannekoek, (1961), pp.37, 106-107.

5. In astronomical parlance "perturbation" means a disturbance of the regular elliptic or other motion of a celestial body, produced by forces other than those causing its regular motion.

6. Bīrūnī, (1879), pp.77-78; (1352 H.S.), pp.97-98.

7. Langdon and Fotheringham, (1928), pp.46-98; Barani (1956), p.liii. Berry (1961), pp.45, 48.

8. Bīrūnī (1879), pp.77; (1352 H.S.), pp.97-98.

months in a row are not out of the question (1). According to Iranian astronomers, four successive full months and three successive empty months are possible, but not more (2). In addition to the natural irregularity of the month-duration, the observability of the moon's phases depends on the longitude and latitude of the observer, as well as on the climate (3). The variables make it almost impossible to predict the future visibility of the new moon; this is still a fundamental problem in the Islamic calendar. It is not relevant here to give details of the difficulties associated with this method of time-reckoning: they are well-known to Moslems and to those concerned with calendars, and particularly the conversion of dates (see Chapter V).

When the beginning of the month is determined by direct observation of the new crescent or of other phases of the moon, lunation is only a rough instrument for time-measurement; it is a difficult task to determine the number of days between two given dates only a few years, or even a few months, apart. The astronomer's determination of the length of the lunar month for calendar purposes is based on the average length of the synodic months, and has no connection with the visibility of the new crescent or other phases of the moon. This artificial solution is in the form of a regular alternation of full and empty months; the months are then referred to as "calculated" or "hollow" (not to be confused with "empty"). There is an occasional interpolation of one day, so that two 30-day months follow one another in leap years.

The adoption of this method probably dates from very early times when man began to reckon by the phases of the moon (4). The Iranians probably became familiar with the hollow month after adopting the Babylonian lunisolar time-reckoning system (5). Bīrūnī (6), in connection with the determination of the length of Ramaḍān, asserts that "some years previously" a pagan sect had adopted the astronomical

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1. Parker and Dubberstein (1946), p.23; Parker (1950), p.6. Cf. Langdon and Fotheringham (1928), pp.23, n.1.45, n.2.

2. Zīj-i Ulugh Beg (1847), p.296; Qūshchī (1330 A.H.), Bāb 9th; Mullā Muẓaffar (1267, 1298 A.H.), Bāb 1st. See also Humā'ī (1316-1318 H.S.), p.220, n.9. Abu'l-Khayr Muḥammad Fārsī (1348-1349 H.S.), p.50. Cf. Bīrūnī (1879), p.138; (1352 H.S.), p.186.

3. See Neugebauer (1952), p.81.

4. Meer (1955), p.1; Berry (1961), p.21.

5. Olmstead (1970), p.328.

6. Bīrūnī (1879), pp.76-77; (1352 H.S.), p.97.

method of determination of the length of the months. From Bīrūnī's explanation it would appear that calculated determination of the month-length by the Moslems goes back as far as the second or third century A.H.(eighth or ninth century A.D.)(1).

Many forms of lunar month, such as tropical (2), anomalistic (3), synodic and sidereal, have been differentiated by astronomers, but the lunar calendar is almost always based on the synodic month and the moon's mansions,which are still mentioned in Iranian almanacs.

A synodic month is the period of time from the point at which the moon is in line with, and between, the earth and the sun ("conjunction", iqtirān), until its return to the same position; it represents the cycle through the sequence of phases from the new moon to the first quarter (lasting about 7.5 days), to the full moon (about 6.75 days), to the third quarter (about 7.75 days), and to the new moon again (about 7.5 days). It takes the moon on average 29.5305883 mean solar days, or 29 days,12 hours,44 minutes,2.87 seconds, to execute a complete revolution round the earth with respect to the sun (4). The length of the synodic month varies from 29.26 to 29.80 days (5). Iranian astronomers of the third and fourth centuries A.H. (ninth and tenth centuries A.D.) arrived at a reasonably accurate calculation of the length of the lunar month. Bīrūnī, in connection with the Jewish 19-year cycle, gives the value of the solar year as 365 days 5 hours and a fraction 3791/4104 of an hour, from which the length of the average lunar month can be calculated as 29.530594 days (6).

A sidereal month is the period of the moon's revolution around the earth from a given fixed star, back again to the same star; its mean period is 27.32166 mean solar days, or 27 days, 7 hours, 43 minutes, 11.5 seconds, which is just over 2.2 days shorter than the synodic month. The period of the sidereal month is determined in connection

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1. For determination of the length of the lunar month by Khwārazmī, see ibn al-Muthannā's commentary (1967), pp.17-18.

2. A "tropical" month is the period of the moon's revolution with respect to the first point of Aries.

3. An "anomalistic" month is the period in which the moon returns to its apogee or perigee. For the early recognition of this kind of month, see Langdon and Fotheringham (1928), p.45, n.3.

4. For early accurate calculation of the length of the lunar month by the Babylonians of the sixth century B.C., see Fotheringham (1931), p.736,and Langdon (1935), pp.10-11.

5. Bīrūnī (1910,I), p.346; (1879), p.77; (1352 H.S.), pp.97-98; and Barani (1956), intro. pp.liii-lv; Berry (1961), pp.47-48, or any other astronomical text-book.

6. Bīrūnī (1879), p.64; (1352 H.S.), p.83.

with the indigenous Chinese-Uyghur calendar in Iranian Zījes of the 13th century onwards as 248 days equal to 9 sidereal months of 27.5555 days. Since this value differs slightly from that of the Chinese, it must have been obtained by the Iranian astronomers themselves (1).

In addition to the various lunar months which have already been mentioned, solar months have also been employed by the Iranians in their indigenous calendars. A solar month is defined as the time taken by the sun to traverse a single constellation. Bīrūnī (2), in this connection, states that "as the lunar month is the twelfth part of the lunar year, the twelfth part of the solar year is a solar month in theory, the calculation being based on the mean rotation of the sun". Generally speaking, the zodiac (3) is an imaginary belt extending eight degrees on either side of the ecliptic and embracing the paths of the sun, moon and planets, as seen from the earth. The zodiac is by convention divided into twelve unequal sections, each named after a constellation. Like the signs of the zodiac, these months, which vary from 29 to 32 days, have names corresponding to the images which they represent; the zodiacal signs appear to be almost identical among the Hindus and all other nations (4).

The signs are of particular interest to the astrologer. Bīrūnī was not a believer in astrology, and was sceptical of the fortune-telling and weather-forecasting (5) practised in his day by many astrologers and believed by most of the people. Despite this scepticism, Bīrūnī has nevertheless provided a detailed survey of the "influences" attributed to the various heavenly bodies and associated with the signs of the zodiac. As far as time-measurement is concerned, interest in the signs of the zodiac is believed by Sayili (6) to have increased by the time of the Saljuqs. Taqīzādeh (7), basing his information on Quṭb al-Dīn (died A.H.710/A.D.1311)(8), observes that, for the Jalālī calendar, certain

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1. Kennedy (1964), p.437.

2. Bīrūnī (1910,I), p.347.

3. For more on the zodiac, see Toulmin and Goodfield (1961), pp.29-30, and Berry (1961), pp.12-14, or any recognized astronomical text-book.

4. Bīrūnī (1910,I), p.347. See also Brennand (1896), p.9.

5. Bīrūnī (1316-1318 H.S.), p.316; Humā'ī (1316-1318 H.S.), intro. pp.14-16 (i.e. (يد) Yd, (يه) Yh, (يو) Yw in Abjad notation). On pp.316, 360, 400 and 538 Humā'ī clearly demonstrates Bīrūnī's lack of sympathy with such beliefs. See also Niẓāmī ʿArūḍī (1910), pp.57-58 and Wright (1934), p.210, n.2.

6. Sayili (1960), p.233.

7. Taqīzādeh (1940-1942), p.117; (1346 H.S.), p.205; (1317 H.S.), p.174, n.325.

8. For Qutb al-Dīn see Sarton (1953,b,II), pp.1017-1020 and Mudarrisī (1335 H.S.), pp.81-82.

astronomers adopted as their months the periods of time for which the sun remains in the zodiac-sign sections. This corroborates an earlier statement to the same effect by Naṣīr al-Dīn Ṭūsī in his Sī-faṣl, chapter VI (1), and in Zīj-i Ilkhānī (2).

Some present-day Iranian almanacs show the solar months bearing the names of the constellations in addition to the lunar mansions (3).

The total time taken by the moon to execute one complete zodiac-cycle is also divided into sections. The number of sections adopted varies from civilization to civilization: the Iranians, like the Arabs, chose 28, calling them "manāzil" (mansions)(4); in India there are 27 "nakshatras" (mansions), which have always played a major role in time-measurement (5). Both the "nakshatras" and the "manāzil" are dependent on the mean sidereal period of the moon. They represent the day-to-day or night-to-night positional variation of the moon in relation to certain stars or star-clusters, from which they take their names. By Arabic and Iranian reckoning, each "manzil" occupies roughly 12.8333^{o} of the ecliptic, and each constellation is constituted on average by 2.333^{o} of a "manzil"(6).

Certain present-day Iranian almanacs show, alongside the "manāzil", the periods of time spent by the moon in the different constellations, varying between two and three days. The sole significance of these periods is astrological. The almanacs still credulously show the degree of propitiousness of the day concerned, e.g. propitious, average, unpropitious; extremely unfavourable, highly favourable, moderately unfavourable; auspicious day for marriage contract, consummation of marriage, etc., ringing the changes with varied expressions of the limited concepts concerned, sometimes repeating the prognostication of the previous day.

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1. Naṣīr al-Dīn Ṭūsī: "Sī-faṣl (treatise in thirty chapters), published in one volume, together with Khulāṣat'l-hīsāb and Hay'at Qūshchī in 1330 A.H., pages unnumbered; elsewhere, when reference is made to this particular work, the year of publication follows the name of the author, or simply the title of the work.

2. Naṣīr al-Dīn Ṭūsī (O.2.(7)), folio 15^{b}.

3. This type of Iranian almanac is discussed by Chardin (1338 H.S.), pp.183-243; Jafarey in Two Twin Calendars, Two Odd Years and Only One City, Rawalpindi, A.D.1973/1351 H.S.; Rajā'ī (1352 H.S.), pp.181-191; Afshār (1353 H.S.), pp.192-196.

4. See the Bundahishn (1880), Ch.2, vs.1-4, pp.10-11; (1956), pp.32-33, and Bīrūnī (1879), p.335 ff.; (1352 H.S.), pp.462 ff. and (1316-1318 H.S.), p.106; see also Brennand (1896), p.19; Nadershah (1900), pp.249-250.

5. Bīrūnī (1910,I), p. 354; Devan Bahadour (1911), pp.15-16, and Kaye(1918), p.72; see also Sewell (1896), pp.21-23.

6. Bīrūnī (1316-1318 H.S.), pp.106-115; (1352 H.S.), p.463.

I.III. Seasons (various forms)

The apparent path of the sun (ecliptic) across the sky intersects the celestial equator at two points in the course of a year. When the sun is traversing from south to north, the point of intersection is known as "the first point of Aries" or "the vernal (spring) equinox". This point marks the beginning of spring in the northern hemisphere. At this point in time, which falls approximately on 21st March, day and night are equal. The autumnal equinox in the northern hemisphere represents the intersection of the southerly-travelling sun with the celestial equator (approximately 21st September), and marks the start of autumn in the northern hemisphere. On this date, day and night are again equal.

For the northern hemisphere, the position of the sun mid-way between the vernal and autumnal equinoxes, when the sun is at its zenith (furthest point north of the celestial equator), is referred to as the summer solstice, or the longest day (approximately 22nd June).

The sun's position furthest south of the celestial equator (nadir) and mid-way between the two equinoxes is known as the winter solstice; in the northern hemisphere this is the shortest day of the year (approximately 22nd December).

Since the solar year does not consist of an integral number of days and is not divisible by 4, the length of the seasons varies from year to year and within the same year.

Our investigation concerns the various arbitrary divisions of the year, as initially practised by the Iranians until they eventually adopted the astronomical seasons.

As far as is known, the division of the year into two unequal seasons was the earliest method employed by the Iranians (1); it presumably dates from the time when they lived in cold regions, somewhere between the Danube and central Asia (2). The country is referred to in the Avesta under the name of Aīryana-Va'ja (3); according to Vandīdād, Fargard I, vs.9-10 (4) "ten winter months are there, two summer months, and these are cold as to the water, cold as to the earth, cold as to the trees" (see also loc.cit., Fargard II,V)(5).

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1. Kuka (1900), p.57; Ginzel (1906), pp.282-283.

2. Ghirshman (1349 H.S.), p.49; Olmstead (1970), p.19. For the date of the Iranian settlement in Iran, see Stronach (1974), p.247.

3. Spiegel (1864), Vandīdād, p.9; West (1885), p.86.

4. Spiegel (1864), Vandīdād, p.3.

5. Spiegel (1864), Vandīdād, vs.47-60, p.16, vs.34 ff., p.41; Pour Davoud (1347 H.S.I), p.319.

Quoting from Minokhirad, Spiegel states: "the 'Dev' (demon) of winter is most vehement in "Eran-Vej" (Aīryana-Va'ja). The winter lasts ten months and summer two months, and these two summer months are cold as to water, cold as to the earth, cold as to the trees"(1).

The two unequal seasons, but by this time a winter of five months and a summer of seven months, are mentioned in the Bundahishn (2): the winter months were Ābān, Adhar, Daī, Bahman and Isfandārmadh. These seasons will be considered in more detail in connection with the Zoroastrian calendar (3).

Although there is no doubt about the existence of the ancient divisions of the year into two seasons, the actual length of the year, the location of the seasonal points, and the historical period when the methods were first used, are all subject to much debate. It is said that the similarity between these seasons and the Vedic and post-Vedic calendars suggests that they stem from the period when the Iranians and Hindus lived together, or at least from the time just prior to the dispersion of these kindred nations (4).

Taqīzādeh speaks of a division at some unspecified time into two equal seasons of six months (i.e. 180 days)(5). He bases his hypothesis on a number of unsubstantiated assumptions and even casts doubts on his own hypothesis in a footnote "if that part of the Avestan word connected with the word 'year' should not prove to mean the 'end' the whole argument loses its basis"(6).

During the two centuries in which Avestan and Pahlavi texts have been translated into European languages, many scholars have attempted to solve the problems relating to the ancient and mediaeval Iranian calendars, particularly those concerning the six Gāhanbārs (unequal seasons). Different scholars have given different sequences and durations for these, according to their personal interpretation of the annual cycles (7), without relating the variations to the calendars currently in use.

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1. Spiegel (1864), Vandīdād, footnote to Fargard I, v.6, p.6.

2. Bundahishn (1880), Ch.25, v.7, p.94; (1956), p.207.

3. See below, p.19.

4. Kuka (1900), p.55; Taqīzādeh (1938), pp.14-15; (1346 H.S.), pp.66-67.

5. Taqīzādeh (1317 H.S.), p.45; (1938), p.15; (1346 H.S.), p.67.

6. Taqīzādeh (1938), p.15, n.2; (1346 H.S.), p.67, n.2.

7. See Nadershah (1900), pp.244-273; also Taqīzädeh (1938), p.11; (1346 H.S.), p.62.

To avoid this pitfall in the present work, the six Iranian Gāhanbārs will be considered in connection with the various Zoroastrian calendars in which they were incorporated (see below, p.112).

Some scholars, through interpretation of the Iranian month-names and the names of the six Gāhanbārs, maintain that the four astronomical seasons had been identified at the time of the ancient Iranian inscriptions and writings (1). On the other hand, even after exhaustive and painstaking research by learned orientalists, it is still uncertain in which century Zoroaster lived (2). Bihrūz (3) makes the unsubstantiated claim that "Zoroaster was born on Monday, the sixth day of the first month of the tenth millenium (4), 645,365 days (1767 solar years) before the Saturday of the Christian era, and he formulated a new astronomical table and corrected the calendar and time-reckoning in use before him". On footnote 2 of the same page he adds, referring to the supposed calendar adjustment: "...it was on Saturday at the hour at which the centre of the sun's disc appears above the horizon of the city of Nīmrūz (Sīstān) on the day of the vernal equinox or the Iranian solar New Year".

In this connection, Taqīzādeh states that "...the year, from early ancient (probably from the most ancient) times, has been divided into four well-known seasons, each of three months, and their names in Pahlavi are as follows..."(5). Taqīzādeh subsequently qualifies this assertion (6): "the time of the introduction of four seasons cannot be determined; although the names, e.g. 'Zarimaya' (Pahlavi meaning: spring or property of spring)(7), or 'vanhari' (used in the Avesta to

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1. Kuka (1900), pp.54 ff.; Bulsara (1953), p.183.

2. See Rawlinson (1879,I), p.323, n.5; Bartholomae (1925), p.8; Herzfeld (1933), pp.132-137; Pettazzoni (1925), pp.149-150; Bharucha (1900), p.11; Taqīzādeh (1947), p.35.

3. Bihrūz (1331 H.S.), pp.133-137; (1346 H.S.), p.3.

4. According to the millennia-doctrine of Zoroastrian chronology, the world lasts 12,000 years. Zoroaster appeared at the end of the ninth millenium (Bundahishn (1880), Ch.1, vs.8-24, pp.51-52; Ch.34, vs.1-9, pp.149-150, including footnotes). Bīrūnī, on the other hand, asserts that Zoroaster appeared when 3,000 years had elapsed from the beginning of the world (see Bīrūnī (1879), p.17; (1352 H.S.), p.24). For different interpretations of the millennia-doctrine, see Herzfeld (1933), pp.132-137; Lewy (1941), p.57-58; (1944), pp.197-215; Taqīzādeh (1947), pp.33-40

5. Taqīzādeh (1317 H.S.), p.45.

6. Taqīzādeh (1346 H.S.), p.528.

7. For the meaning of the Pahlavi words, see Nadershah (1900), pp.259 ff.; Pour Davoud (1347 H.S.,II), pp.501 ff.; Taqīzādeh (1317 H.S.), p.45.

mean spring), or 'saridha' (probably meaning autumn), were probably in existence, they refer to parts of the year and not to the regular seasons".

It is not within the scope of this work to consider Bihrūz' hypotheses and exaggeratedly nationalistic claims, which have been accepted without due scrutiny by certain Iranian scholars (1). It is rather strange that Bihrūz should claim that Zoroaster wasable to determine the vernal equinox at Nīmrūz when the geographical co-ordinates of that location had not been accurately calculated centuries after his death (2), and particularly since astronomical knowledge must have been inadequate for such purposes during Zoroaster's lifetime (3).

With regard to the determination of the dividing points between the seasons on the ecliptic, the two solstitial points marking the beginning of summer and winter present no difficulty and can easily be ascertained by observation and by using primitive instruments. The two equinoctial points, on the other hand, do constitute a problem. Bīrūnī refers to the attendant difficulties: "...if the perpendicular shadow at the summer-solstice is observed, and the level shadow at the winter-solstice, in whatsoever place of the Earth the observation be made, the observer cannot possibly mistake the day of the solstice, though he may be entirely ignorant in geometry and astronomy, ...on the other hand the two equinoctial days cannot be ascertained, unless you have found beforehand the latitude of the place and the general declination. And this nobody will find out unless he studies astronomy and has profited something thereby, and knows how to place and how to use the instruments of observation".(4).

In view of the fact that astronomical instruments, and knowledge of the determination of latitude, longitude and general declination, stated by Bīrūnī as being fundamental to determination of the equinoctial points, were not sufficiently advanced even in the ninth and tenth centuries A.D.(5), it is difficult to accept that the Iranian peoples knew and used four astronomical seasons in ancient times.

Although Bihrūz believes that historical and calendar literature, and the dates contained therein, have been manipulated and adulterated by the Manichaeans (6), one of the books he frequently cites, namely

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1. See Rīyāḍī Kirmānī (1352 H.S.), pp.753-754, where the author accepts Bihrūz' claim, but changes the date of the Nīmrūz observation to 1725 years before the Christian era. For the refutation of Bihrūz' claims, see Muḥiṭ Ṭabāṭabā'ī (2535 Sh.), p.375.

2. Bulsara (1953), p.178.

3. Fotheringham (1919), pp.168-169.

4. Bīrūnī (1879), p.201; (1352 H.S.), p.281; (1910,I), pp.356-368. See also Pannekoek (1961), p.107.

5. Sayili (1960), pp.80 ff.; Kennedy (1968), pp.659 ff.

6. Bihrūz (1331 H.S.), pp.12-13, 119-120.

the Bundahishn, appears to be free from such influence, particularly with regard to parts of the text not relating to historical dates. Notwithstanding the fact that the point in time, after which the night lengthens and the day becomes shorter, is unique, the author of the Bundahishn considered all five days of the "Maidhyūshima" as being roughly the longest of the year and as being of equal duration (1). Such a statement clearly demonstrates the inadequacy of astronomical knowledge, not only in Zoroaster's time, but centuries later.

The four astronomical seasons are mentioned in the Bundahishn without specific reference to their starting points (2). Details of the seasons appear in a chapter of the Pahlavi Dinkard, where they are given as four in number, starting with spring, when the sun reaches the first degree of Aries, and lasting three months while the sun passes through the constellations of Aries, Taurus and Gemini (3). The same book mentions the three other seasons and gives a method for relating the months to their proper season by intercalating days (4).

An alternative division of the year into non-consecutive month-groupings appears in certain ancient sources. In Zīj-i Shāh, known variously as Zīk-i Shatro-ayār and Zīj-i Shahrīyārān-i (al) Shāh (5), there are four such groupings, each associated with one of the four "elements":

Fire: Aries, Leo, Sagittarius

Earth: Taurus, Virgo, Capricorn

Air: Gemini, Libra, Aquarius

Water: Cancer, Scorpio, Pisces

Nallino (6) states that "the twelve signs of the zodiac have been divided into four groupings of three signs each". This complicated division of the year, with three months allocated to each of the elements, is used in much historical and calendar literature as a gauge of the passage of time.

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1. Bundahishn (1880), Ch.25, vs.3-6, pp.91-94; (1956), pp.205-207.

2. Bundahishn (1880), Ch.25, vs.20-22, pp.97; (1956), ch.25, vs.25-26, pp.209-210. See also Gray (1910), p.128; Bulsara (1953), pp.179-183.

3. Dinkard (1900), pp.21 ff.

4. Dinkard (1900), pp.21-26.

5. Kennedy (1958), p.259, Pingree (1956), p.334.

6. Nallino (1949 H.S.), p.233.

Although Bīrūnī (1) and other atronomers of the ninth and tenth centuries A.D. define the four seasons in full astronomical and scientific terms, as far as calendars are concerned, the Iranians did not pay much attention to seasons prior to the Jalālī calendar in the eleventh century.

The pre-Islamic Iranians were unable to observe the starting points of the seasons with any degree of precision (see Chapter II).

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1. Bīrūnī (1879), p.322; (1352 H.S.), pp.445-446; (1910,I), pp.347, 356-358.

I.IV. Years (various forms)

In astronomical terms a year is the period of the earth's revolution about the sun (1), relative to a certain reference star. The durations of the various astronomical years, which depend on natural phenomena, will vary according to the reference star selected and will not consist of an exact number of days. Although the length of a calendar year or, as astronomers call it, the "civil year", is as close as possible to the duration of the astronomical year, it will always consist of an exact number of days, i.e. a portion of one day will be included in one year, the remainder of that day being counted in the succeeding year or years.

The various solutions adopted to reconcile the differences between astronomical and civil years were found by primitive and mediaeval peoples to be difficult to operate satisfactorily. These difficulties sometimes prompted changes in the method of time-reckoning, even within a single community.

On the other hand, some calendars are based on the lunar year of twelve lunar months, which is some eleven days shorter than the natural or tropical year. Since the natural year defines the annual recurrence of the seasons, it is inevitable that in the lunar calendar the beginning of each season will fall "earlier" in succeeding years. The necessity for observing the seasons, which in ancient times was felt strongly in religious and professional circles, led to the adoption of a variety of solutions, including the so-called "lunisolar" or "bound solar" calendars (2).

Historical records do not appear to include details of the above alternative solutions. Scattered information is available, but even collectively it is insufficient to explain all the systems which were adopted.

In Iran the conception of "year" varied from period to period and in different communities. In this work, the various solar and lunar astronomical years will first be defined; an attempt will then be made to describe systems of time-reckoning for which available information is inadequate, in the hope that future archaeological discoveries and research will provide the "missing links" required to complete the calendars concerned.

The length of the astronomical year varies slightly through the ages, but this variation does not become significant until several thousand years have elapsed; it does not therefore need to be taken into account when considering calendars (see Chapter IV).

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1. Ancient and mediaeval astronomers also applied the term "year" to the times of revolution of each of the planets: Mars, Jupiter and Saturn, etc.; each had its own year, consisting of the number of days it took to complete one revolution.

2. Olmstead, (1970), p.6.

It is very important when studying ancient and mediaeval calendars to remember that contemporary knowledge of astronomy was inadequate for accurate measurement of the astronomical year. It is pointless to attempt retrogressive calculations to determine the nature of ancient and mediaeval calendars. Many scholars have probably been guilty of errors as a direct result of overlooking this point (1).

Previous sections made mention of the astronomical definitions of nychthemeron, lunar and solar month, all depending on the rotation of the Earth on its axis and its orbit around the sun, and also on the revolution of the moon about the Earth. A full astronomical definition of the various years is beyond the scope of this work, but since it is the most important unit of time-measurement, a brief explanation is necessary for the study of ancient and mediaeval calendars and time-measurement.

The solar or "tropical" year, sometimes erroneously referred to as the "calendar" year, is measured from the point at which the sun is at the vernal equinox until it reaches the same point again. Since the tropical year begins about the same date in the modern Christian and Iranian calendars, the calendar keeps in step with the seasons. For this reason, the year is often also referred to as a "natural" or "seasonal" year. The length of the solar year is 365.2422 days, or 365 days, 5 hours, 48 minutes, 46.8 seconds.

The sidereal or true length of the astronomical year is measured in relation to a fixed reference-star, its length being determined by the heliacal rising of stars. The sidereal year is longer than the tropical year by about 20 minutes 23.424 seconds, by virtue of the retrograde motion of the equinoctial points. The length of the sidereal year is thus 365.2563 days, or 365 days, 6 hours, 9 minutes, 9.5 seconds (2).

The duration of the lunar year or "calendar lunar year", is always based on the length of the synodic month. Thus the mean length of twelve lunar months is 12 x 29.530589 = 354.367 days, or 354 days, 8 hours, 48 minutes, 34.675 seconds. The length of the lunar year, like that of the solar year, varies slightly throughout the ages, but the difference is so small that it is insignificant in the study of calendars.

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1. See Dicks (1970), p.9.

2. It is generally accepted that the ancient Egyptians were the first to base their calendar on the first observable rising of Sathis (Sirius or Dogstar) at dawn; the year or even the century in which this was introduced is uncertain. Parker ((1950), p.53) states that it must have been introduced between c. 2937 B.C. and c. 2821 B.C. Neugebauer ((1945), p.5), who subscribes to the above origin of the earliest Egyptian calendar, and Fotheringham ((1931), p.734), place the year around 2800 B.C. Some scholars prefer the fourth or fifth century B.C., arriving at this conclusion by reverse extrapolation (see Sarton (1953,a), p.29).

The solution which has been unanimously adopted by Iranian astronomers to reconcile the length of twelve lunar months and the length of the civil lunar calendar is based on a cycle of 30 lunar years, 11 of which are leap years of 355 days, and 19 of which are common years of 354 days. In each cycle of 30 years, the years 2, 5, 7, 10, 13, 16, 18, 21, 24, 26 and 29 are leap years. Instead of the year 16, some astronomers prefer the 15th year, in which the "fractions" have already accumulated to more than 12 hours (1).

Any attempts to bring the lunar calendar into line with the solar or seasonal year would have been made at times when some kind of administration appeared in the region using that calendar. The early insertion of an intercalary month in the lunar year, which is usually credited to the Sumerians, as early as 3000 B.C. (2), would be accomplished in order to harmonize the lunar months and the agricultural year for the collection of taxes and tributes (3).

We have already discussed the average length of solar and lunar years, which were the basis of various calendar years. The average length of 12 lunar months (one ordinary lunar year) is about 354.3670 days; this is shorter by approximately 10 days 21 hours than the tropical year of about 365.2422 days. By the same token, the tropical year is 18 days, 15 hours, 43 minutes less than 13 lunar months, the so-called "embolismic" year. As a result of the discrepancy between the lengths of the tropical year and "ordinary" lunar year, the 12 months of the true lunar calendar retrogress annually by 11 days in relation to the solar calendar years. The same will apply to the solar calendar year, but the shift will be about 19 days. In the calendar of 12 lunar months, the difference after three years will be about 33 days; after $32\frac{1}{2}$ solar years the date of the solar year will have fallen one year behind the date of the lunar year (4). This discrepancy necessitated the addition of an extra month to the calendar of 12 lunar months every 2 or 3 years, or for a whole year to be interpolated every 32 or 33 years, to make the lunar calendar correspond more closely to the seasonal or solar calendars.

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1. See Ibn al-Muthannā's Commentary (1967), pp.16-17, and Bīrūnī (1934), p.164; (1316-1318 H.S.), p.223 including footnote 2; Naṣīr al-Dīn Ṭūsī (O.2(7)), fol.13; Ulugh Beg (1847), pp.294-297; Bīrjandī (Ethe 2233), fol.4[a]; Abdollahy (1352 H.S.), pp.734-735, ns.3-4.

2. See Langdon (1935), pp.10, 67 ff; Bickerman (1969), p.22; Fotheringham (1931), p.735; Olmstead (1970), pp.200-201.

3. Olmstead (1938,a), p.116.

4. See Ḥamza of Isfahan (1932), table on pages 49 ff;(1346 H.S.), table on pages 166 ff; also Meritt (1964), p.236, and van der Waerden (1960), p.170.

Fotheringham is of the opinion that "at Babylon the month so repeated was most commonly the last month 'Addaru', but not infrequently the sixth month 'Ululu' (a practice which remained in use during the Achaemenid dynasty and even during the first century B.C.)(1), and very occasionally some other month"(2). According to Langdon, "an early Babylonian calendar, of which only the tenth-century edition of Assyria has been preserved, used 'Nisan' as the only intercalary month. But the Sumerian calendars on which it was based used intercalary 'Adar'"(3). This "ad hoc" intercalation was only regularized at a later date, not later than the sixth century B.C., which is the period under consideration here.

It is possible that the Sumerians used an 8-year cycle (octaeteris) before adopting the 19-year cycle (4). Bīrūnī (5), in connection with the Jewish calendar, asserts that it was on the night of 15th Nisan at the time of the full moon (6), when the Israelites were ordered by Moses to observe this day as a feast-day, that they began to make joint use of the lunar and solar years. The desire soon arose among the Israelites to keep this day in the spring, and in their quest for a suitable method, they considered five different cycles: an 8-year cycle of 99 months, three of which were intercalary months; a 19-year cycle, consisting of 235 months, seven of which were intercalary months; a 76-year cycle of 940 months, 28 of which were intercalary months; a 95-year cycle of 1,176 months, 35 of which were intercalary months; a 532-year cycle, consisting of 6,580 months, 196 of them being intercalary months. Bīrūnī explains that, since, out of these five lunisolar-systems, the 8-year and 19-year cycles were easier to observe than the

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1. See below, pp.40,51.

2. Fotheringham (1931), p.735.

3. Langdon (1935), p.51. · See also Langdon and Fotheringham (1925), p.60; Sprengling (1911), p.248. Bīrūnī ((1879), pp.63, 69; (1352 H.S.), pp.81-82, 89) explains the Jews' opinion regarding the different methods of interpolation of months in the embolismic year. He asserts that the Ananites (one of the Jewish sects) inserted the intercalary month as a second Shabath (11th month), while the Rabbanites interpolated it as a duplicate Addar (12th month); the Jews were not even unanimous over which of the two was the original month: some thought the original month was the first Addar, whereas others believed the second month (Addar II) to be the original. Bīrūnī is of the opinion that the second Addar is in fact the original month, which is in the same part of the year in relation to the sign of the zodiac. Cf. Aid to Bible understanding (1971), pp.277, 279.

4. See Fotheringham (1931), p.736; Poebel (1939,a), p.302, n.3; Bickerman (1969), p.23; Olmstead (1970), pp.200-201, 209.

5. Bīrūnī (1879), pp.63-64; (1352 H.S.), pp.82-83.

6. According to Bīrūnī, it was during the exodus of the Jews from Egypt that Moses gave these instructions to the Israelites; also according to Bīrūnī ((1879), p.21; (1352 H.S.), p.28), his Jewish contemporaries agreed to fix the interval between the exodus of the Israelites from Egypt and the era of Alexander as 1000 complete years.

others, the Israelites adopted the 19-year cycle, which was the most accurate of the two (1). He expounds the Israelites' calculations of the 8-year and 19-year cycles in detail (2).

The values given by Bīrūnī for the solar year and lunar month, i.e. 365.2468 days and 29.53059 days respectively, are very close to their true lengths. Such accuracy was beyond the capabilities of the civilization in the second millenium B.C. Bīrūnī's accuracy is in itself remarkable when his figures are compared with findings made in the fourth century B.C. by the Babylonian astronomer Kidinnu, following the development of the regular 19-year Babylonian cycle (3).

Greek astronomers also employed the 8-year cycle from the sixth century B.C. onwards (4): an intercalary cycle of 8-years, consisting of 99 lunar months, three of which were intercalary, totalling 2922 days. Since the correct length of 99 lunations is 2923.53 days, and 8 tropical years are roughly equivalent to 2920 days, this method rapidly led to a large error in the date of new-moon visibility and to a shift of the months away from their initial seasons. Several solutions were devised: sub-cycles of 16 and 160 years were consequently used to bring the lunar and solar years into almost exact agreement (5).

It is now generally accepted that the 19-year cycle was adopted by the Babylonians in 747 B.C. (6). The starting point of our interest in this cycle is the second part of the sixth century B.C., when the Achaemenians used it as their official state calendar (7). The scientifically-based regular "Metonic" 19-year cycle was devised by the Greek astronomer Meton in 432 B.C. (8); the Babylonian 19-year

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1. Bīrūnī (1879), pp.63-64: (1352 H.S.), pp.83-84. Cf. Sprengling (1911), p.240.

2. Bīrūnī (1879), p.64; (1352 H.S.), pp.83-84.

3. See Fotheringham (1931), p.736, and Chapter II of this work.

4. Fotheringham (1931), p.736; Pannekoek (1961), pp.107-108; Dicks (1970), pp.87, 188-189.

5. Pannekoek (1961), p.107.

6. Olmstead (1938,a), p.118; (1970), p.200; Parker and Dubberstein (1946), p.1, n.1; Parker (1941), pp.292-293, n.22; Poebel (1939,a), p.302, n.3. Cf. Fotheringham (1919), p.181; (1931), p.736, and Neugebauer (1952), pp.7, 96-97.

7. See below, Chapter II.

8. Butcher (1877), p.15; Nicolas (1833), p.24; Fotheringham (1931), pp.736-738; Neugebauer (1952), pp.7, 97; Meritt (1964), pp. 200 ff.; Olmstead (1970), pp.329, 342; Dicks (1970), pp.87-88; also almost all astronomical and chronological literature.

cycle with regular intercalary months was not introduced until 367 B.C. (1). The latter system is attributed to the Babylonian astronomer Kidinnu (2). Since the innovation occurred during the Achaemenid period and this cycle was used by the Achaemenians, it will be discussed in connection with Achaemenid time-reckoning in Chapter II.

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1. Fotheringham (1931), p.736; Olmstead (1938,b), p.393; (1970), pp.328-330, 453-454; Parker and Dubberstein (1946), pp.2-3, also Plate I facing p.4, and table pages 33 ff; also Bickerman (1969), p.24.

2. Fotheringham (1931), p.736; Olmstead (1938,b), p.393.

I.V. Subdivision of months (various forms)

The Iranians had no weeks or "decades" (10-day periods) prior to the Arab conquest (1), but allocated to the successive days of the month a variety of names denoting God and significant features of the Zoroastrian religion, (see Table 1). The first day of each month was dedicated to the supreme God, Ahuramazda or Hurmazd; the 8th, 15th and 23rd days of each month are called Dīn, apparently indicating religious days (2); to avoid confusion, Dīn is followed by the name of the following day. The days of the month are reckoned in relation to these four religious days in four groups of days, the first day of each group being a feast-day, which may originally have been celebrated as a day of rest or market-day (3).

The four Iranian divisions of the month differ from the universal seven-day week in various ways:

1. The four Iranian groups of days add up to the same total as the 30 days of the Iranian month, and are fixed in relation to the month.

2. The Iranian day-groupings are not of equal length: the first two consist of seven days each, the second two of eight days.

3. The names of the Iranian days are not repeated in the course of a month; they consequently do not appear more than twelve times a year.

In view of the continued presence of Jews in Iran since the Achaemenid period and of Christians within the Parthian (Arsacid) and Sasanian Kingdoms, and in view of the close relationship between the Iranians and these peoples and the Babylonians, certain authors claim that, although the Iranians named the days according to their traditional system prior to the advent of Islam, they were also familiar with the seven-day week (4). On the other hand, not a single document from the period prior to the advent of Islam has so far been dated by a seven-day-week day-name.

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1. See Ya'qūbī (1347 H.S.), p.217; Mas'ūdī (1347 H.S.), p.555; Bīrūnī (1879), p.58; (1352 H.S.), p.75; (1934), p.277; (1316-1318 H.S.), pp.233-234; Zīj-i Ulugh Beg (1847), p.339; Bīrjandī (Ethe 2237), fol. 17^{a-b}; Mullā Muẓaffar (1267, 1298 A.H.), Bāb 2nd. See also Spiegel (1864), Khurda-Avesta, footnote p.145; West (1880), p.406, n.1; Darmesteter (1883), pp.1 ff.

2. West (1880), p.406, n.1; Darmesteter (1883), pp.1 ff.

3. Cf. Nadershah (1900), pp.246-249 and Lewy (1941), p.64, n.2.

4. Kasravī (1335 H.S.), pp.239-240; Mu'īn (1325 H.S.), p.4.

In Darius' Bīsutūn inscription, the days of the month are numbered rather than named. The days of the month appearing on the Nisa documents bear Zoroastrian names. The same applies to the period of the Sasanian dynasty, during which the Zoroastrian names of the month-days were in common use (see Chapter III.I, III.II).

Although reference is made to a seven-day period in the first book of the Bible (1), adoption by the Jews of the seven-day week as an element of dating and reckoning the month-days goes back to the first century A.D. (2). (Roman) Christians reckoned the days of the month by reference to the Kalends, Nones and Ides (3) until Constantine became Emperor and issued an edict in A.D.321, introducing the seven-day week into the Julian calendar (4).

The origin of the seven-day week is also a matter of controversy. It was probably related in the earlier lunar calendar to the four phases of the moon, each of about seven days' duration (5). In this connection, according to Langdon, the Babylonians employed a seven-day week by which the seventh, fourteenth, twenty-first and twenty-eighth days of each lunar month were days of rest (6). The Babylonian seven-day week fixed within the lunar month has a certain similarity to the

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1. Genesis, Ch.2, vs.2-3; see also Colson (1926), pp.7, 12-13, and Aid to Bible Understanding (1971), p.1650.

2. Report of the Calendar Committee (1955), pp.169; Bickerman (1969), p.59.

3. Many of the Dura Europos texts from the second century A.D. are dated by reference to Nones, Kalends (Calends) and Ides (see Wells (1959), papyri Nos.29, 54, 58, 66, 74, 83, 89 on pp.152, 158, 169). The days of the month were reckoned retrogressively in relation to the three fixed points of the month. The Kalends was the first day of the month; the Nones was the fifth, excepting in March, May, July and October, when it fell on the seventh day; the Ides in these same four months was the 15th, and in all the other months the 13th day:

> In March, July, October, May,
> The Ides are on the fifteenth day,
> The Nones the seventh: all other months besides,
> Have two days less for Nones and Ides.
> (Trad.)

4. King (1957), p.61; Bickerman (1969), p.61.

5. Fotheringham (1910), p.63; Colson (1926), pp.2-10; Langdon (1935), pp.89-92; see also Report of the Calendar Committee (1955), p.169.

6. Langdon (1935), pp.89-90. Cf. Colson (1926), pp.12-13.

above first and second features of Iranian month-day appellation, but adoption of the Babylonian method by the Iranians would appear to be highly improbable. According to Langdon, the Babylonian scheme of a seven-day week was used some time between 1000 B.C. and 600 B.C.(1), whereas the Iranian method with different days of rest from those of the Babylonians and with the days tied to the month of 30 days appeared in the third and second centuries B.C. on the eastern border of present-day Iran (2).

The seven-day week must have been adopted by those Iranians who discarded their ancestors' religion and embraced Islam. Zoroastrian communities of the twentieth century still reckon and divide the months in accordance with the traditional Iranian system on which the Yazdgirdī-calendar is based. Their calendars are not plagued by the difficulties associated with the seven-day week which destroyed the perpetual nature of the calendar through the fact that the anniversary of an event seldom falls on the same day of the week as the original event (3).

After the Arab conquest, those Iranians who adopted the seven-day week were not unanimous in their choice of the starting point of the week. Iranian astronomers, astrologers and historians started the week with Sunday until the twelfth century A.D. (4), but, since the day of rest or feast-day in the Islamic world is Jum'a (Friday), they gradually began to reckon from the day after their holiday, i.e. Shanba (Saturday), which is still the practice today. In the Sī-faṣl of Naṣīr al-Dīn Ṭūsī, there is a passage on the days of the week in which he states that "the week-days and their numerical signs in the calendar are as follows: Yik-Shanba (Sunday) "١" (one), Du-Shanba (Monday) "٢" (two)", and so on up to Shanba (Saturday) "٧" (seven)(5). According to the anonymous annotation "those people who believe the first day of the week is Shanba (Saturday) employ the "٠" (zero) as the numerical sign for Shanba". Present-day Iranians employ numbers followed by "Shanba" for five days of the week, the first being Shanba itself; Yik-Shanba, Du-Shanba, Si-Shanba, Chahār-Shanba and Panj-Shanba; the week ends with Jum'a (Friday), also called Ādina, which is the day of rest.

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1. Langdon (1935), pp.89-90.

2. See Chapter II, pp.76ff.

3. See Chapter V.

4. See Mas'ūdī (1344 H.S.), pp.25, 559; Ya'qūbī (1347 H.S.), p.287; Bīrūnī (1879), pp.75-76; (1352 H.S.), p.95; (1910,I), p.213; Ibn al-Muthannā (1967), p.17. Cf. Ṭabarī (1352-1354 H.S.), pp.12-13, 25.

5. Naṣīr al-Dīn Ṭūsī (1330 A.H.), Faṣl 2nd, marginal note.

The word Shanba, which is etymologically identical to "Sabbath", was given to the Iranians by the Semites (1). Its origin is a subject of controversy: in all probability, it came from Hebrew or Babylonian (2).

There was an almost universal astrological belief early in the Christian period that the 24 hours of the day were each governed by one of the seven heavenly bodies (3) (Sun, Moon and planets), in the order of their supposed distance from the Earth (4), in descending order of magnitude, i.e. Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon. Saturn ruled the first hour of Saturday and was therefore regarded as "Lord" of that day; the second hour of Saturday was ruled by Jupiter, the third by Mars, and so on. According to this sequence, the Lord of the eighth, 15th and 22nd hours of Saturday would be Saturn itself, the 23rd would be ruled by Jupiter, the 24th by Mars; the first hours of successive days were associated with the Moon, Mars, Mercury, Jupiter and Venus, respectively.

Iranian astronomers (5) also looked upon the planets as rulers of the week-days, but they began with the Sun: the first day was therefore Sunday (6).

The appellation of the seven week-days after seven heavenly bodies is attributed to the Babylonians (7); it is also connected with Iranian astrological or theological belief (8) and the sacredness of the number seven (9).

On the basis of interpretation of the Zoroastrian names of the month-days, a claim has been made that the second group of Iranian month-days, headed by "Dīn-pa-Atar", are individually named after seven heavenly bodies (10). This does not prove that the origin of the appellation of the week-days is Iranian, since as the names themselves show, the first, second and sixth are associated with the angels of fire, water and "primeval ox", respectively, and the third,

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1. Mu'īn (1325 H.S.), p.4; Pour Davoud (1347 H.S.,I), p.79.
2. Langdon (1335), p.89. Cf. Bihrūz (1347 H.S.), pp.11-15.
3. Colson (1926), pp.18, 43-44; Sarton (1959), p.328.
4. Ibid, pp.44 ff.
5. Bīrūnī (1910,I), p.213.
6. Ibid, p.213.
7. Neugebauer (1952), p.164.
8. Hartner (1965), pp.3, 8; Bickerman (1969), p.61.
9. Encyclopaedia Britannica (15th ed.), Vol.3, p.596.
10. Nadershah (1900), pp.247-248.

fourth and fifth bear the names of the Sun, the Moon and Mercury, respectively (1).

The sacredness of the number seven among the Iranians is derived from their mythology. Mordecai (Esther Ch.1, vs.5, 10, 14), when speaking of Ahasuerus (Xerxes - خشایارشا), repeats the number seven on several occasions. The story of the seven exploits of Rustam (2), the seven heavens (3), seven Amshāspandān (4), and seven princes of Pārs (5), and many other stories, make mention of the number seven (6), but none indicates that the planetary week figures in the Iranian religion.

Another method for reckoning the month-days was also used by the Arabs, and occasionally by the Iranians, for dating events, instead of the system of month-day and week-day: Mas'ūdī (7), Ya'qūbī (8) and Bīrūnī (9) express the belief that the Arabs had special names for every group of three successive nights of the lunar month, derived from the phases of the moon and its brightness during the three-day period. The Iranians adopted the Arabic term "Ghurra" for the first day of the month, "Badr" for the 14th, and "Salkh" for the last day of the month, whenever the lunar month contained 30 days; otherwise "Salkh" was omitted.

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1. West (1880), pp.404-405; see also Darmesteter (1883), pp.1-20.

2. Fīrdawsī (1335 H.S.), pp.298-334.

3. Ṭabarī (1352 -1354 H.S.), pp.26, 33; Mas'ūdī (1344 H.S.), p.582.

4. Darmesteter (1883), pp.35-40; Nadershah (1900), p.246. Cf. Christensen (1343 H.S.), p.13.

5. Herodotus (1974), pp.234-237. See also Olmstead (1970), p.109; Pīrnīyā (1344 H.S.), p.523.

6. Ṭabarī (1352-1354 H.S.), p.35, 99. See also Christensen (1343 H.S.), pp.80, 112, 121.

7. Mas'ūdī (1344 H.S.), pp.560-563.

8. Ya'qūbī (1347 H.S.), pp.287-288.

9. Bīrūnī (1879), pp.74-75; (1352 H.S.), pp.95-96.

CHAPTER II

Pre-Zoroastrian calendars

II.I. Pre-Achaemenid time-reckoning

In view of the scarcity of information about the pre-Achaemenid period, the question of the systems of time-reckoning used in this period is a subject of conjecture and uncertainty. Various hypotheses have been put forward, usually accompanied by attempted explanations of Bīrūnī's statement: "I have heard that the (mythical) Pīshdādian Kings of the Persians, those who ruled over the entire world, reckoned the year as 360 days, and each month as 30 days, without any addition or subtraction; that they intercalated one month in every sixth year which they called 'intercalary month' and two months in every 120th year; the one on account of the five days (the epagomenae), the other on account of the quarter of a day; that they held this year in high honour, and called it 'blessed year', and that in it they occupied themselves with the affairs of divine worship and matters of public interest"(1). According to this (too perfect) time-reckoning, the length of the year in this double cycle of 6 and 120 years can be calculated as follows:

1 year = 12 months of 30 days = 360 days

6 years of 360 days + 1 month = 2190 days

120 years = 20 (6-year cycle + 1 month) = 43,830 days

43,830 ÷ 120 years = 365.25 days

Taqīzādeh is of the view that: "this sort of intercalation may be a very old Aryan or Indo-European practice"(2). Kuka (3) believes that the Indo-Aryans calculated the length of their year as accurately as possible, but their limited knowledge forced them to adopt the sidereal year (4) for their religious calendar. Kuka also quotes the Indian chronologer Tilak, who places the Indians' first consideration of calendar problems as early as 4000 B.C. The existence of such an "advanced" calendar at such a relatively prehistoric period would be difficult to substantiate. This is the period which Tilak and certain

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1. Bīrūnī (1879), p.13; (1352 H.S.), p.18.
2. Taqīzādeh (1938), p.13; (1317 H.S.), p.18.
3. Kuka (1900), pp.54-55.
4. See above, p.21.

scholars have arrived at for the Rig-Veda (1). According to one interpretation of the Rig-Veda I.164.II (2), the year in the original time-reckoning of that period consisted of 360 days, divided into twelve months. It seems that the division of the year into two distinct parts, each of six months, referred to in the "Report of the Calendar Reform Committee of the Government of India", quoting "the great Vedic scholar" Dr. Martin Haug (3), and claimed by many to be the most ancient division of the year, was related to a year of 360 days (4) which is neither a solar nor a lunar year, but an arbitrary year. The year of twelve months, each of thirty days, with an occasional 30-day intercalary month, but with no indication of any definite intercalation cycle (5), is not as old as the straight 360-day year (6). Some time later (depending on the antiquity of various Vedic writings), the North-West Indians (7) adopted the five-year cycle of 1830 solar days (8). At the same time the North-West Indians added a third season (9), so that they had a hot, a rainy and a cold season (10); this division

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1. Report of the Calendar Committee (1955), pp.214-215. The most ancient writings of the Hindus are the Vedas, which are supposed by their followers to be of divine origin. Vedic literature is divided into several widely-spaced periods. Although the dates of these periods are uncertain, the Rig-Veda is taken by common consent to be the oldest. Kaye ((1918), p.71) states that "Vedic astronomy is more poetical than exact, and it is of interest, apart from its poetic value, chiefly as a subject of controversy. Certain scholars, e.g. Dikshit, Tilak, Jacobi and others, argue, from rather vague astronomical premises, partly based on the texts, an extreme antiquity for the Vedic writings; others do not accept the views". See also Bīrūnī (1910,I), pp.125-127, and Humā'ī (1340 H.S.), p.99; Encyclopaedia Britannica (15th edition), vol.3, p.607.

2. Report of the Calendar Committee (1955), p.216.

3. Ibid, p.216.

4. Nilsson (1920), p.73; Taqīzādeh (1317 H.S.), p.82; (1938), p.14.

5. Kaye (1918), p.71; Report of the Calendar Committee (1955), pp.216, 218.

6. Ibid; see also Brennand (1896), p.65.

7. It is generally accepted that Vedic literature originates from the North-West of India. The authors concerned refer to themselves as Aryas or Aryans; see Report of the Calendar Committee(1955), p.215.

8. Kaye (1918), p.72; see also Brennand (1896), p.65; Report of the Calendar Committee (1955), p.225.

9. The division of year into three parts was ascribed to many communities, including Egyptians and Greeks (see Nilsson (1920), pp.47 ff., 64, 72-73; Brennand (1896), p.30; Achelis (1930), p.22).

10. Nilsson (1920), p.73.

continued to be used in the Vedas. Later, two transitional seasons were interpolated, one of autumnal character, between the rainy and cold seasons, the other a warm (spring) period between the cold and hot seasons (1). Finally, the North-West Indians divided the cold season into two shorter periods, to finish up with six seasons (spring, hot, rainy, autumn, winter and cool)(2). Bīrūnī's definition of six Indian seasons is not the same as the above. He states that "Hindus do not divide the year into four, but into six parts, which are called 'ritu' and each comprehends two solar months, i.e. the period of the sun's passage through two consecutive zodiacal signs"(3). Bīrūnī also demonstrates the position of these seasons relative to the zodiac (4).

Despite claims made by certain scholars, there is no real similarity between the early Indian calendars described by Bīrūnī or derived from Vedic literature and the early Iranian calendar ascribed by Bīrūnī to the Pīshdādian kings (5). The figures used by Bīrūnī, in particular a year of 365.25 days, a month of 30 days and an intercalation cycle of 120 years, are admittedly the same as those characterizing the Zoroastrian calendar (6). The only difference between the Iranian time-reckoning mentioned by Bīrūnī (alone) and the Zoroastrian calendar is that of the location of the five supplementary days. Whereas in the early Iranian calendar ascribed by Bīrūnī to the Pīshdādian kings the epagomenae were accumulated over a period of six years, at which point one month of 30 days was intercalated, in the Zoroastrian calendar the five days were originally placed at the end of each year (7). There can be no doubt that this innovation was a comparatively late development in the early Iranian calendar, completely unrelated to the Indian calendars. This has been clearly demonstrated by Boyce (8). We have already tabulated the names of the Zoroastrian month-days (Table 1) which are given in the Avesta and also by Bīrūnī, who observed that the Iranians were unanimous

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1. Nilsson (1920), p.73.

2. Ibid.

3. See Bīrūnī (1910,I), pp.357, 359. See also Taqīzādeh (1938), pp.14-15; (1346 H.S.), p.66 and Report of the Calendar Committee (1955), pp.238-242.

4. Bīrūnī (1910,I), p.357.

5. Cf. Kuka (1900), pp.54-55; Taqīzādeh (1938), pp.14-15;(1346 H.S.), p.66; Boyce (1975), p.135.

6. See Chapter III.

7. See Chapter III.

8. See Boyce (1970), pp.514-515.

in this regard, except for the first and last days "Hurmuz" and "Anīrān", for which he gives the alternative forms "Farrukh" and "Bihrūz"(1). As for the five supplementary days, Bīrūnī points to a wide variety of written and spoken forms. The names of the five days do not appear as such in the Avesta, but are frequently used therein as the five Gāthās (2).

In conjunction with the arguments put forward by Boyce, the above suggests that the Zoroastrian names of the month-days were first used in the pre-Achaemenid calendar. The names of the months were from the same origin as the month-days and carried the names of the six archangels "Amshāspandān" (Ashāvahīsta, Haurrvatāt, Armiritāt, Khshthravaīrya, Virithraghna, Spinta Ārmaītī), other angels (Fravashī, Mithra, Tīshtshrya, Daina), and the elements (Ātār, Āpān), appearing in the Zoroastrian scriptures.

In Table 1 it will be observed that the names of twelve of the days are the same as the names of the months given above. According to Mu'īn, the months received their names before the days of the month (3). This hypothesis was derived from Marquart's assertion and Taqīzādeh's statements that "the Sogdian months were in the Sogdian language, whereas the names of the days of the month were of Zoroastrian origin and were only adopted at a later date"(4). This should not be interpreted as implying that the Iranians as a whole adopted the Zoroastrian month-names before the day-names. There has been much discussion in Iranian literature about the exact derivation and etymology of the names and the order of the months; the latter will be dealt with in connection with the Zoroastrian calendar (see Chapter II, sections I and II).

Let us reconsider Bīrūnī's views on early Iranian time-reckoning, quoted in the first paragraph of this section. These have been interpreted in different ways by various scholars. Boyce, for example, comments: "In Islamic times royal use of this calendar was ascribed, according to al-Bīrūnī, to the mythical Pēšdādians; but that (the) Parthian and Pēšdādian should be confused by the tenth century A.D. is not improbable. The historical (Parthian) dynasty was by then almost forgotten, whereas the Pēšdādians were celebrated in scripture and epic as the first rulers upon earth, who had invented most things"(5).

Elsewhere in the same article, Boyce appears to be unaware of Bīrūnī's repeated statements that a calendar of 365 days with a 120-year intercalation-cycle was in use long before the Arsacid (Parthian)

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1. See Bīrūnī (1879), p.53; (1352 H.S.), p.69.

2. See Mu'īn (1325 H.S.), p.3.

3. Mu'īn (1325), pp.2-3.

4. Taqīzādeh (1317 H.S.), pp.121-122; Mu'īn (1325 H.S.), pp.2-3. Cf. Taqīzādeh (1938), pp.2-4.

5. Boyce (1970), p.517.

period. For example, in al-Āthār al-Bāqīya, he states that "the ancient Iranians used a solar year of 365 days and 6 hours...after the coming of Zoroaster and the transfer by the Iranian kings of their residence from Balkh (Bactria) to Fārs and Babylon, they paid attention to matters relating to their religion and they ordered new observations to be made, then found that in the third year after intercalation, the summer solstice preceded the beginning of the year by five days"(1). Bīrūnī does not specify, either by name or dynasty, which king made the solar calendar of 365 days with a 120-year intercalation-cycle more accurate on the strength of the Babylonian observations of the length of the solar year. Positive identification can however be made, using Bīrūnī himself as a source: amongst others, he states that the kings of the Kayānian dynasty moved from Balkh to Babylon (2). Although Bīrūnī, like many other post-Islamic Iranian and Arab authors, speaks of the Kayānian dynasty when he obviously means the Achaemenid, authors of the 10th century A.D. certainly ought not to have confused the Kayānians and the Sasanians, to whom Boyce attributed the institution of the 365-day calendar. Moreover, Bīrūnī tabulated the duration of the reigns of the Pīshdādian and Ashkānian (Parthian, Arsacid) kings (3), using data gleaned from various sources. He gathered information about these periods by word of mouth, had access to Persian and Arabic sources, and was capable of understanding Sanskrit and perhaps even Greek literature (4). This was the sound foundation of his knowledge with regard to the dynasties in question, about which he is unlikely, therefore, to be confused.

Bīrūnī clearly differentiates between the Pīshdādians and the Parthians. He divides the chronology of the Iranians into three periods (5):

1. From Gayūmarth, the first king of the Pīshdādians, until the slaying of Darius III by Alexander (Iskandar);

2. From Alexander until the establishment of the Sasanid dynasty by Ardashīr;

3. The period of the Sasanid dynasty.

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1. Bīrūnī (1879), p.220; (1352 H.S.), p.308. Cf. Taqīzādeh (1938), p.23 and (1346 H.S.), p.75, where the author, by his parenthetic explanations, completely changes the significance of passages from Bīrūnī in favour of his own hypothesis.

2. Bīrūnī (1879), p.100; (1352 H.S.), p.128. See also Ṭabarī (1352-1354 H.S.), pp,478-482; Ḥamza of Isfahan (1346 H.S.), pp.35-39; Mas'ūdi (1344 H.S.), pp.218-227; Christensen (1343 H.S.), pp.49-52.

3. Bīrūnī (1879), pp.107-122; (1352 H.S.), pp.151-164.

4. See Sachau (1910,I), pp.xxxix-xlii; Browne (1921), pp.62, n.1, 127-129; Lewy (1944), pp.198, n.12, 199, n.25, 200; Barani (1956), pp.viii-ix.

5. Bīrūnī (1879), p.107; (1352 H.S.), p.141.

Bīrūnī is fully aware of the fact that, since the Pīshdādians are the first Iranian monarchs to figure in Iranian mythology, their period can only be estimated roughly (1). It is clear that the mythical Pīshdādians referred to by Bīrūnī represent the Iranian people of the earliest times, classified together with the Achaemenids (2) as the Kayānian Kings. With regard to accounts of the Arsacid period by Moslem (Muslim) historians, who referred to them as "Petty Princes", Bīrūnī states: "I shall relate in this place such of their traditions as I have learned, and shall endeavour, as much as is in my power, to amend that which is wrong, to refute that which is false and to establish the truth (3).

It is strange that certain scholars have quoted Bīrūnī's statement about the Pīshdādian year in such a way that the length of the year becomes 360 days (4). This is the result of the omission of the

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1. Kennedy and van der Waerden ([1963], p.319) state that "in the three versions of the Persian traditional chronology reported by Bīrūnī (al-Āthār al-Bāqiya, pp.109-114, 200-203, 220), the reign of the legendary Jam (shīd), son of Tahmūrath of the Pīshdādian dynasty (probably fourth or sixth king), falls approximately between the years -3400 and -2800 of the Christian era". Cf. West (1897), p.xxix , in which according to the Bundahishn the date is given as 3347 B.C. See also Christensen (1343 H.S.), pp.106 ff.

2. See Ginzel (1906), p.293; Lewy (1941), p.13, n.3, p.63; Taqīzādeh (1938), p.16; (1346 H.S.), p.68.

3. Bīrūnī (1879), pp.116-117; (1352 H.S.), p.156. See also Frye (1976), p.200, where he states "Islamic authors reflect Sasanian tradition on the Parthians, and there is a curious reduction of the time span between Alexander and the rise of the Sasanians which can be found in many Islamic sources. The great scholar al-Bīrūnī knew of this blunder by many of the historians, and, following Ḥamza al-Iṣfahānī, he gives the various false chronologies current in his time, as well as several almost correct tables." See also Lewy (1944), pp.197 ff.

4. Boyce (1970), pp.516-517. Taqīzādeh, who is a supporter of an early Iranian 360 day-calendar, which he calls "Old-Avestan", is of the opinion that "the year of 360 days was perhaps the first step in the transition from a lunar to a solar year, being half-way between 354 and 365 days"; (Taqīzādeh (1938), p.16, n.3; (1346 H.S.), p.68, n.3). Cf. Paruck (1937), p.54, where the same assertion is made, relating to a supposed 360-day Babylonian and Egyptian calendar. The compound terms Old-Avestan, Old-Persian and Young-Avestan, which appear frequently throughout Taqīzādeh's works, applied to supposed Iranian calendars, have led to confusion.

Old-Avestan and Old-Persian are the names applied to the Persian languages used at certain periods: the former was in use from the time when the Iranians separated from the Indians until almost the end of the eighth century B.C.; the latter was the language used in the cuneiform inscriptions of the Achaemenid dynasty from the sixth century B.C. up till the conquest by Alexander (see Kent (1953), p.6 ff. and Humā'ī (1340 H.S.), pp.104-113). Neither the significance of these two terms nor that of "Young-Avestan" is satisfactorily explained by Taqīzādeh.

second part of a single statement in which Bīrūnī clearly explains the method of intercalation in the early Iranian calendar (1).

The Persian translator of the al-Āthār al-Bāqiya translated the above-mentioned passage by Bīrūnī, which is a unique report of the pre-Achaemenid period, in such a way that the length of the year would be 365½ days. This is the result of a slight mis-translation concerning the two intercalary months which have to be inserted in the 120th year, i.e. one on account of the five supplementary days of the six last years of the 120-year cycle, the other on account of the quarter days in the 120-year cycle. Dānāsirisht's translation gives one month in every six years and two additional months in every 120-year cycle, i.e. one month too much for the cycle as a whole (2).

The pre-Achaemenid calendar must have originated in the North-East of Iran, where the Zoroastrian calendar appeared in later centuries (3). The Achaemenians' use of Babylonian time-reckoning will be discussed in the next section. There are good grounds for supposing that the pre-Achaemenid time-reckoning system did not reach the eastern region of Iran or, as Bīrūnī indicates, it was only used in matters relating to religion, rather than official government activities (4).

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1. The quotation of Bīrūnī's passage by Boyce reads as follows: "Thirdly al-Bīrūnī records the tradition that a 360-day calendar was used by the ancient kings of Persia. Of it he writes 'I have heard that the Pešdādian kings of the Persians...reckoned the year as 360 days, and each month as 30 days, without any addition or subtraction...that they held this year in high honour, and called it the 'blessed year', and that in it they occupied themselves with the affairs of divine worship and matters of public interest'".

2. Dānāsirisht (1352 H.S.), p.18. See also Gray (1910), p.129.

3. See Chapter III, Sections I and II.

4. See Boyce (1970), pp.516 ff.

II.II. Achaemenid time-reckoning

We have already discussed in Section II.I the pre-Achaemenid time-reckoning of a 365.25-day year with complicated intercalary months at intervals of 6 and 120 years, attributed by Bīrūnī to the Pīshdādian kings. No mention was made of the first Iranian dynasty (the Medes), which, according to Herodotus, lasted for over 150 years (1), and whose realm probably extended from Halys to the river Oxus (2). Many historians still maintain that the Achaemenians were at least in certain aspects inheritors of the Median culture (3) and that the two dynasties should therefore be studied jointly. Although the Achaemenians used the Babylonian lunisolar system of time-reckoning, which they probably adopted directly from the Babylonians (see below), it is perhaps advisable to follow the classical division of Iranian history.

In the absence of written documents relating to Median culture, much of what has been written about the Medes is inevitably pure supposition. The nearest thing to written evidence available is two golden tablets totalling 24 lines in the Old-Persian language (4), probably written at the time of Ariarmnes (Ariyaramna) and his son Arsames (Arshāma), two Achaemenid petty kings who were contemporaries of the Medes (5). The Medes were capable of writing; according to Herodotus "all suits were conveyed to him (Deioces or Dayāukku (c.700 B.C.), founder of the Median Empire) in the form of written documents"(6). The kings of the Medes probably kept state documents in a safe place (7); they had to pay tribute to the Assyrian kings, at least for certain periods of their rule (8). They must have had

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1. Herodotus (1974), Book I, 103-130, pp.83-95. Cf. Rawlinson (1879,II), p.415, n.1. On the records relating variously to four, seven or nine Median sovereigns, see Rawlinson (1879,II), pp.377-378, 382, n.2, 383 and Pīrnīyā (1344 H.S.), pp.176-218.

2. Rawlinson (1879,II), pp.383, 392, 398-399, 401, 428, n.11. See also Pīrnīyā (1344 H.S.), pp.191-194, 199-200; Behmanesh (1350 H.S.), plate 4; Frye (1976), pp.80-81.

3. See Rawlinson (1879,III), pp.347-348; Bīzhan (1316 H.S.), pp.138 ff.; Frye (1976), p.102.

4. See Kent (1953), pp.107, 116; Ghirshman (1349 H.S.), pp. 126-127, 131-132.

5. See Frye (1976), p.86; Pīrnīyā (1944 H.S.), pp.228-232.

6. Herodotus (1974), Book I, 103, p.83.

7. See Rawlinson (1879,II), p.311 and footnote 17 same page; also Bīzhan (1316 H.S.), p.120.

8. See Rawlinson (1879,II), pp.377-381; Olmstead (1970), p.23.

some method of time-reckoning for their yearly, monthly and daily activities. Their successors, the Achaemenians, adopted the Babylonian calendar, but substituted the Old-Persian month-names. It is possible that the Persian month-names were also used by the Medes, but this is an assumption which cannot be proved or disproved. Since the capital city of the Medes, Ecbātānā (present-day Hamadān), has been inhabited throughout the ages, the vestiges of Median culture may well have been destroyed with the development of the city; the unresolved question of the Median system of time-reckoning must therefore await further archaeological finds in Hamadān or some other Median centre.

There can be no doubt that the official calendar of the Achaemenians was the Babylonian lunisolar system. The first Iranian dated document using this method of time-reckoning belongs to the reign of Darius I (522-486 B.C.). There is no direct or indirect information about the method of time-reckoning in Eastern Iran during the reign of the first three Achaemenid kings. Later literature gives no clue to the Iranian method of time-reckoning during the reign of Cyrus II (559-530 B.C.), Cambyses II (530-522 B.C.) and Bardīyā (Smerdis, Gaumātā) (seven months in 522 B.C.). Darius commanded the Babylonian astronomers to make the calendar more exact (1). Existing evidence indicates that the Babylonian calendar, with an intercalary month of a second Addaru (12th month; Old-Persian Viyakhna) or a second Ululu (the corresponding Old-Persian form of this month is not known; see Table 3)(2) was adopted without modification during the reign of Darius I. In the Bīsutūn (Behistan) inscription, Darius has precisely recorded the day and the month in which the events of the first three years of his reign occurred, but has not clearly recorded the years (3). The Fortification and Treasury Tablets of Persepolis are dated by a similar method, giving the day, month and regnal year of an unspecified king. The problem of relating the Persepolis Tablets to the regnal years concerned was a major task. The successful attempts at solving the problem, by Poebel (4), Hallock (5), Cameron and many others, have been summarized by Cameron (6). Determination of the date of the tablet-inscriptions depended on various factors which defy absolutely

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1. Olmstead (1970), p.200; see also Iliffe (1953), p.10.

2. Since two of the twelve Old-Persian month-names are still unknown, i.e. the sixth and the eleventh, the corresponding Babylonian months will be used in this section. Table 3 gives the corresponding current Elamite, Jewish and Old-Persian month-names. The sequence of the Old-Persian months will be discussed in the present section.

3. See Hallock (1960,a), p.36. Cf. Rawlinson (1879,III), p.416.

4. See Poebel (1938,a), pp.130-141; (1939,a), pp.301-304.

5. See Hallock (1942), pp.230-232; (1960, b), pp.90 ff.

6. Cameron, Persepolis Treasury Tablets (1948), pp.1, 32-33.

accurate calculation. The Fortification Tablets are dated variously between the 14th and 28th years of the reign of Darius I, corresponding to 508 to 494 B.C. (1). The Treasury Tablets are placed between 492 and 460 B.C., equated with the 30th year of Darius' reign and the fifth year of Artaxerxes I (Longimanus Artakhshassa)(465-424 B.C.), covering the intervening reign of Xerxes I (Khshāyārshā)(486-465 B.C.)(2). The use of the Babylonian lunisolar system from the early years of Darius' reign is attested by the dates on the Bīsutūn inscription and by the assignment of the Persepolis Tablets to the overall period 508 to 489 B.C. Cameron observes that "the name of an Old-Persian month as it appeared in both the Old-Persian and Elamite version (of the Bīsutūn inscription) was merely replaced, in the Akkadian version, by the name of the corresponding Babylonian month; the twenty-seventh day of Anamaka (10th month), for example, was equated with the twenty-seventh day of Tebetu (10th month)"(3). This is confirmed by the dates in the Aramaic (parchment) version of the inscription, which, as Darius himself states, was sent to several satrapies (4). This conclusive evidence shows that the Babylonian lunisolar calendar was undoubtedly in use from the early years of Darius' reign until at least the first five years of the reign of Artaxerxes I, and underwent no modifications during this period (5).

A collection of artefacts, of an entirely different nature, was also discovered in the Persepolis Treasury (6). In contrast to the Fortification and Treasury Tablets, which were treasury documents written in cuneiform Elamite and were used for the payment of workmen's wages (7), these "ritual objects" (8) are mortars, pestles, plates and trays, most of them inscribed with Aramaic script (9);

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1. See Hallock (1950), p.237; (1958), p.256. Cf. Cameron (1948), pp.1, 32-33.

2. See Cameron (1948), pp.1, 32-33, 85, 194-196, Tablets 1^{a}, 79; also Gershevitch (1951-1952), p.132.

3. Cameron (1948), p.35.

4. See Cowley (1923), pp.248, 257-265. Cf. Kent (1953), pp.120-128.

5. See Cameron (1948), p.34. Cf. West (1897), p.xlv.

6. See Schmidt (1957), pp.16 ff.; Bowman (1970), pp.v, 1-5; Cameron (1948), pp.33-34.

7. See Cameron (1948), pp.9, n.48 and 24 ff.; Hallock (1960,^{b}), p.90. See also Gershevitch (1951-1952), p.132.

8. Schmidt (1957), p.16 ff.; see also Bowman (1970), p.6.

9. See Schmidt (1957), p.16; Bowman (1970), p.16.

according to Schmidt and Bowman, they were used in the Haoma religious ceremony (1) at the Achaemenid court (2). Although the dating of the ritual objects, which only bear the regnal years of unspecified kings, cannot be precisely determined and probably extends over a long period, the objects are important in contributing to a fuller understanding of the time-reckoning of the Achaemenid dynasty. Bowman is of the opinion that the datable objects are from the time of Xerxes (486-465 B.C.); the oldest, which is a mortar, is inscribed with the seventh year of the reign of this monarch (3). With regard to the undatable objects, Bowman considers them to be from later than the 29th year of Artaxerxes I (436/435 B.C.)(4). Cameron, in his preliminary examination of these artefacts, believes that the dates are regnal years of Artaxerxes I (465-424 B.C.) and his successor Darius II (424-405 B.C.) or, less probably, Artaxerxes II (405-359 B.C.) and his successor Artaxerxes III (359-338 B.C.)(5). It is apparent from a consideration of the ritual objects themselves that many, if not all, of the factors which could assist in dating them have been obliterated by the passage of more than 23 centuries (6). Thus the dates can only be placed approximately in a relatively long period (7) and may cover the whole period of the Achaemenid dynasty. Whereas for modern scholars dating by the regnal year has the drawback that no reference is made to the king's name, which is also true of the Fortification and Treasury Tablets, for those living at the time such a method of dating was perfectly adequate. Since the Haoma ceremony was celebrated once a year (8) either on Mihragān (9) or Nawrūz (10), and the time-reckoning for religious purposes was the same as the contemporary time-reckoning used on the Fortification and Treasury Tablets, there was no need to give other information about the month and month-day, which were always the same for this ceremony.

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1. See Schmidt (1957), p.55; Bowman (1970), p.6.

2. Bowman (1970), p.6 ff.

3. See Bowman (1970), pp.57-58, 60 and Table 1, also Mortar 1 on page 71.

4. Bowman (1970), pp.57, n.14; p.122, Table 52.

5. Cameron (1948), p.34; cf. Bowman (1970), p.57, where Bowman states that Cameron now concurs with the assignment of the ritual objects to the period covering the seventh year of Xerxes up to the 29th year of Artaxerxes. See also Schmidt (1957), pp.55-56.

6. Bowman (1970), pp.152 ff.

7. Bowman (1970), pp.56, 58-65 and Table 1.

8. Bowman (1970), p.8. It is not certain whether the Haoma ceremony was performed with the advent of winter, when the Raftungāh was omitted, or in the spring when this gāh was re-introduced.

9. Bowman (1970), p.8; Cameron (1948), p.8.

10. Bowman (1970), p.36.

There are many other possibilities regarding the dating of the ritual objects. It is possible that, since only the year-dates appear on these objects and the precise nature of their calendar cannot be determined definitively, the objection to the above conclusion is raised that the calendar by which the dates on the ritual objects are given is not the same as that of the Bīsutūn inscription and the Persepolis Tablets. This objection can only be countered by determining the nature of the calendar employed in the Bīsutūn and Persepolis documents (1).

Every calendar or method of time-reckoning has a fixed starting point (era or epoch). Bīrūnī (2) gives the following definition: "the eras serve to fix certain moments of time which are mentioned in some historical or astronomical connection". With regard to the accession-year system of dating, the epoch is the first New Year's Day after the king's accession, which constitutes the era for dates on written documents (3). The term "non-accession-year" system applies to the case where the portion of the year prior to the New Year's Day in which a new king would accede to the throne is counted as his first year (4).

The Babylonians counted the regnal years as full years beginning on 1st Nisanu (5). According to their method (accession-year system), the months during which a new king was on the throne prior to 1st Nisanu were not regarded as the first year of a king's reign, but as his accession year (6).

In column IV of the Bīsutūn inscription (7), Darius repeatedly states: "...I did by the favour of Ahuramazda in one and the same year after I became king"(8). Although the beginning and end of

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1. See below pp.47 ff.

2. See Bīrūnī, India (1910,II), Ch.XLIX, p.1.

3. See Dubberstein (1938), p.418.

4. See Thiele (1944), p.143, n.15.

5. See Parker (1941), pp.297 ff.; Thiele (1944), p.143, n.15; Sprengling (1911), pp.254, 255; Bickerman (1944), p.74.

6. See Poebel (1939, b), p.121, n.3.

7. Darius' Bīsutūn inscription, Paras. 52, 57, 59 and 62: see Kent (1953), pp.131-132; Rawlinson (1847), pp.xxxv-xxxvii, 241-251; Williams Jackson (1906), pp.196 ff.

8. The translations of the Elamite and Babylonian version of the Bīsutūn inscription have not been consulted, but according to Hallock ((1960,a)p.36), the Elamite version reads "one year". In Rawlinson ((1847), pp.241-251), the expression "in one and the same year" is not mentioned. See also Ogden (1933), p.361; Poebel (1938,b), pp.298, 313; Pīrnīyā (1344 H.S.), pp.532-534, 538-549; see also Frye (1976), p.96-99; cf. Olmstead (1938, b), pp.394-395, 399.

the "one year" is a matter of conjecture (1), it is generally accepted that the "one year" would be counted from his accession year into his first official year (2). Darius was not, therefore, at that time using the method of reckoning the year in practice in Babylon (3).

In column V of the Bīsutūn inscription, which is from a slightly later date than the first four columns (4), Darius is reported as saying "This is what I did in both the second and the third year after that I became king"(5). Column V does not carry a date with a day and month, although the expression "both the second and third year" cannot even now be regarded as reliable (6), since Rawlinson (7) could not read or fill-in the weathered part of this column, although this has been done by Kent and others (8). In view of the dates on column IV, it seems that Darius did not count the years either by the accession-year or by the non-accession-year system, but counted them from the time he acceded to the throne, probably from the slaying of Gaumātā on 10th Bāgayādi (7th month; Babylonian, Tashritu) to the next Bāgayādi, and so on for his second and third year. Reckoning by the accession-year system, which first appears on the Fortification Tablets (14th year of Darius' reign) must have continued throughout the Achaemenid dynasty.

Because of communication difficulties between communities in different parts of the country (9), news of the old king's demise would not have reached some (10) and would not have been believed by others (11). Evidence relating to the beginning of a king's reign

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1. See Hallock (1960,a), pp.36 ff; Frye (1976), pp.97-99.

2. Hallock (1960,a), pp.36ff;Poebel (1938,b), p.313; cf. Kent (1943), p.105.

3. See Bickerman (1944), p.74.

4. See Kent (1943), pp.105, 109; Rawlinson (1847), pp.lxii-lxvii. Williams Jackson did not study this column of the Bīsutūn inscription. See also Cawley (1923), p.284.

5. Darius' Bīsutūn inscription, Para.71; see Kent (1943), p.109; (1953), pp.132-135.

6. See Poebel (1938,b), pp.292-293; Kent (1943), p.105.

7. See Rawlinson (1847), pp.lxvii-lxx, 258-261.

8. This part of the Bīsutūn inscription is illegible: running water has washed away parts of the inscription; see Williams Jackson (1906), pp.190-194.

9. Sprengling (1911), pp.259-260; Olmstead (1938, b), p.397.

10. Cameron (1941), pp. 314-315.

11. Sprengling (1911), p.259.

consequently varies by a few days or more than a year, depending on the location of the finds. It is in fact almost impossible to determine the era of the Achaemenid kings. Although most of the evidence, particularly for the first three monarchs, comes from Babylonian chronicles, it originates from different cities and is often not in agreement (1). An example of this deviation can be found in the collection of Aramaic papyri from the Jewish colony at Assuan-Elephantine: papyrus No. 6 (2) carries the date of the 21st year of Xerxes' reign, which can be shown to be the year after his death. The implication is that news of the accession of his successor, Artaxerxes I, which took place some time between June and August 465 B.C. (3), at least five months before Nisanu (first month of the Jewish and Babylonian calendars), did not reach Egypt until after 18th Kislev (4) (ninth month of Jewish calendar), which was more than 10 months later (5); alternatively, the people did not accept the truth of the announcement of the accession of the new king.

One further point deserves mention before we leave the subject of accession and regnal years. A certain number of the Aramaic papyri from the Assuan-Elephantine collection, which according to Bickerman (6) are dated by the Achaemenian method, are double-dated: e.g. Papyrus No. 25 (7) is dated the eighth year of Darius II (416 B.C.; the year begins on 1st Nisanu or 1st Adukanīsh by Iranian reckoning) (8), and

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1. Parker and Dubberstein (1946), pp.11-17; Cameron (1941), pp.319-321, n.28, 33.

2. Sayce and Cowley (1906), Papyrus B (37107), p.36-37; Cowley (1923), Papyrus No. 6; Parker (1941), p.290. Fotheringham ((1909), p.17) gives the corresponding date of this papyrus as 2nd January 464 B.C., whereas according to Knobel ((1908), p.10) the beginning of the 21st year of Xerxes' reign was in December 466 B.C.; Parker and Dubberstein ((1946), p.30) give the date as 27th January 465 B.C.

3. See Parker and Dubberstein (1946), p.15; cf. Knobel (1909), p.8.

4. See Fotheringham (1909), p.14.

5. See Knobel (1908), p.11.

6. Bickerman (1967), p.205; (1969), pp.24-25; see also Sprengling (1911), pp.234, 237; Parker (1941), pp. 288-289; Horn and Wood (1954), p.4; Porten (1968), pp.vii-xi; cf. Sayce and Cowley (1906), p.4; Cowley (1923), p.xiv, Fotheringham (1908), pp.14, 19. The question of identification of the Assuan-Elephantine calendar cannot be discussed here, but since many of the characteristic features of the Jewish and Iranian calendars are still uncertain, precise identification is impossible in any case.

7. Sayce and Cowley (1906), Papyrus J; also cited in Cowley (1923), pp.83-88; see also Horn and Wood (1954), pp.5, 15; Fotheringham (1908), p.17.

8. Horn and Wood (1954), p.3.

also the ninth year of Darius II (416 B.C.; the year begins on 1st Thoth by Egyptian reckoning). Similarly, Papyrus No. 28 (1) carries the 13th and 14th years of the same king's reign (2). The explanation is that the Egyptian year began on the first day of Thoth (December)(3), while the Iranian, as well as the Babylonian and Jewish New Year fell on 1st Nisanu (Adukanīsh), near to, or shortly after, the vernal equinox (4), and about three to four months after the Egyptian New Year. If the accession year of a king fell on or before 1st Thoth, the Egyptians set the start of the regnal year at the first day of Thoth, i.e. three to four months earlier than the Babylonians, the Iranians and the Jews. During the first three or four months of what the Egyptians would regard as the second regnal year, the Babylonians and their imitators were still in their first regnal year (5). There was also the possibility of the accession of a king taking place between 1st Thoth and 1st Nisanu, in which case the first nine or ten Babylonian months, which were for the Babylonians the first regnal year, were still the accession year to the Egyptians, as a result of which the regnal year of the latter is sometimes one less than that of the Babylonians (6).

An in-depth consideration of the chronology of the Achaemenian kings or of any other Iranian dynasty is beyond the scope of this work; contradictory evidence would in any case make reliable conclusions difficult. We must, however, devote a modicum of attention to the determination of the eras, without which time-reckoning is impossible.

Let us again consider the era of Darius I, whose reign lasted for 36 years (7). Much has been written about his accession year, but most of the evidence is inconclusive. While there is common agreement regarding the limits of the reign of Cyrus II (559-530 B.C.)

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1. See Sayce and Cowley (1906), Papyrus K; also cited in Cowley (1923), pp.103-106; Parker (1941), p.292; Horn and Wood (1954), pp.5-6, 15. Fotheringham ((1908), p.17 and Knobel (1908), p.10) give the corresponding date of this papyrus as 10th February 410 B.C.

2. For other double-dated documents, see Bowman (1941), pp. 202-206.

3. Sprengling (1911), p.237; see also Parker (1941), pp.288 ff.; (1950), pp.23, 43-46; Fotheringham (1908), p.14.

4. See Dubberstein (1938), p.418; Horn and Wood (1954), p.13; Fotheringham (1908), p.447.

5. See Horn and Wood (1954), p.5.

6. Parker (1941), pp.299-301.

7. See The Almagest (1952), p.466; Bīrūnī (1879), p.115; (1352 H.S.), p.153; Cameron (1941), p.318; Parker (1941), pp.287-288, 292, 296.

and Cambyses (530-522 B.C.)(1), the reign of Bardīyā (Smerdis, Gaumātā), Darius' immediate predecessor, remains a subject of controversy. According to Herodotus, Gaumātā was killed in the eighth month of his reign (2). Olmstead at one time believed that Gaumata reigned for one year and seven months (3). Poebel (4), Parker (5), Cameron (6), and Dubberstein (7), who studied the question separately, all arrived at a result of seven months, chiefly on the basis of quotations from the Bīsutūn inscription. The inscription relates that: Gaumātā began his campaign to oust Cambyses on 14th Viyakhna (Addaru, 12th month of the year) (see Table 3), seized the throne on 9th Garmapada (Duzu, fourth month), and was killed by Darius on 10th Bāgayādī (Tashritu, seventh month)(8). If, as Poebel suggests, we assume that the events took place in successive years, but that the start of Gaumātā's "coup d'état" marked the beginning of his reign, we arrive at a theoretical duration of seven months (9). This would mean that the Bīsutūn inscription is in agreement with Herodotus. On the other hand, according to the inscription, the period from Gaumātā's seizure of the throne until his death at the hands of Darius (10) lasted three months. Under the alternative assumption that Gaumātā's seizure of the throne and his murder occurred in successive years, his reign would be one of 15 months (11). Even

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1. Mediaeval Moslem authors were either unaware of the very existence of some of the Achaemenian kings or tended to confuse them. See Ḥamza of Isfahan (1932), pp.24-27; (1346 H.S.), pp.10, 22, 30-40; Bīrūnī (1879), pp.112-115; (1352 H.S.), pp.150-154; Ya'qūbī (1347 H.S.), pp.193-194; Mas'ūdī (1344 H.S.), pp.220-224; Ibn Athīr (1349 H.S.), pp.52-53.

2. Herodotus (1974), Book 3, 66, p.232; mediaeval Iranian literature is sketchy and of little help in this connection.

3. Olmstead (1938, b), pp.398, 419. See also Kuka (1900), pp. 61-62; Justi (1925), pp.234 ff. Cf. Olmstead (1970), pp.92-93.

4. Poebel (1938, b), pp.142-165, 285-314; (1939, b), pp.121-145.

5. Parker (1941), p.285-295.

6. Cameron (1941), pp.314-318.

7. Dubberstein (1938), pp.417-419.

8. Darius' Bīsutūn inscription, Paras. 11, 13; cited in Kent (1953), p.12 and Rawlinson (1847), pp.xxix, 204.

9. Poebel (1939, b), p.121; cf. Kuka (1900), p.62, in which he placed the two months in the same year, with an interval of eight months.

10. See Darius' Bīsutūn inscription, Para. 13; cited in Kent (1953), p.120. Cf. Herodotus (1974), Book 3, 79, p.237.

11. This calculation is, of course, not accurate for the year 521, in which an Addaru II was intercalated. No reference was made to Gaumata's coup d'état taking place in Addaru II; see Parker and Dubberstein (1946), p.28.

if Gaumātā reigned for longer than one year (either one year and three months or one year and seven months), it is not necessary to insert a year between the death of Cambyses and the accession of Darius, which can be proved conclusively to be within one year of each other (1). Cambyses arrived in Egypt in 525 B.C. (2); his military expedition to North and North-West Africa lasted nearly three years (3). While returning to Iran with his troops, he received news of Gaumātā's successful "coup"(4), whereupon he committed suicide (5). Cambyses had been accompanied through his African campaign by the future king Darius I (6). On account of the time-lags caused by communication difficulties, and in view of the statement about Gaumātā's revolt in paragraphs 10 and 11 of the Bīsutūn inscription ("when Cambyses had gone off to Egypt, after that the people became evil...both in Persia and Media...and other provinces...he [Gaumātā] seized the kingdom"(7)), there must clearly have been an "overlap" of the two reigns, the reign of Gaumātā actually being included in the last two years of Cambyses' reign (8).

For the eras of Xerxes, Artaxerxes I, Darius II and Artaxerxes II, contemporary evidence collected by Parker and Dubberstein exhibits discrepancies varying from a few days to several months (9). These do not affect the regnal years: even when the evidence of the death of a king, or the accession-year of his immediate successor, varies by as much as several months, provided all the items bear dates before the first day of the first month of the following year, the nominal number of the regnal year will not be affected because the regnal year always begins on the first New Year's Day after the accession of the new king.

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1. Cf. Parker (1941), pp.285, n.2, 287 ff.

2. See Rawlinson (1879,III), p.393; Cowley (1923), p.xvi; Olmstead (1970), p.88.

3. See Rawlinson (1879,III), p.383, n. 2: "The absence of an oriental monarch from his capital for more than one, or at the most two years, produces almost certainly a revolution".

4. See Herodotus (1974), Book 3, 64-66, p.230-232; cf. Rawlinson (1879,III), pp.397-398; Williams Jackson (1906), p.187.

5. See Darius' Bīsutūn inscription, Para.11, cited in Kent (1953), p.120; cf. Herodotus (1974), Book 3, 66, p.232; Rawlinson (1879,III), pp.397-399; Justi (1925), pp.235-236.

6. Herodotus (1974), Book 3, 139, p.261; cf. Justi (1925), pp.234-235.

7. See Kent (1953), p.119.

8. See Justi (1925), p.235, n.3: "...Gaumata had already been recognised as king before the death of Cambyses..."; see also Cameron (1941), pp.314-315; Horn and Wood (1954), pp.12 ff; Parker (1955), p.274.

9. Parker and Dubberstein (1946), pp.14-16; Cameron (1941), pp.319-325.

The latest unambiguously-dated Iranian documents from the Achaemenian period belong to the reign of Artaxerxes I (1). No Iranian documents are available relating to the period during which the last five Achaemenian kings ruled over Iran. Partly for this reason, it is impossible to reach definite conclusions about the duration of the reigns of these five kings. Even if documents were available, the lack of evidence regarding intercalation of months in the period from 459 B.C. until the end of the Achaemenid dynasty would make it pointless to attempt to determine the regnal eras in this period (2).

Let us return to the other feature of Achaemenid time-reckoning: the sequence of the Old-Persian months. Mistakes in this quarter have led to misunderstandings with regard to the Achaemenid calendar among certain scholars, who were working on the subject before Poebel finally arrived at a definitive and convincing month-sequence.

Olmstead has expressed the general agreement of scholars with Poebel's work on the names and order of the Old-Persian months (3). Poebel (4) based his findings on some 30,000 tablets and tablet-fragments discovered at Persepolis by Herzfeld and Schmidt (5). His sequence of the eight Old-Persian months, whose names were first discovered by Rawlinson while deciphering Darius' Bīsutūn inscription in the middle of the last century, was entirely different from the sequences arrived at by Rawlinson himself and others, such as Oppert, Unger, Justi, Prašek, King and Thompson, all of whom enjoyed some support from other scholars (6). In Table 2 several of these incorrect sequences are tabulated alongside Cameron's correct (but incomplete) sequence.

Poebel gives the order of the Old-Persian months, as far as they are known, together with the corresponding Elamite and Babylonian months (7):

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1. Cameron (1948), pp.1, 34, 194-196 and Tablet No. 79.

2. For the chronological order of the Achaemenid kings, see Parker and Dubberstein (1946), pp.11-17.

3. Olmstead (1938, b), pp.292-293; Cameron ((1948), p.41, n.6) independently reaches the same conclusion; Kent ((1953), p.160, n.1) considers Poebel's work to be without par. Cf. Taqīzādeh (1346 H.S.), p.538.

4. Poebel (1938, a), pp.130-141.

5. See Poebel (1939, a), p.301; Cameron (1948), pp.1, 18-19.

6. The sequences of Rawlinson, Oppert, Unger, Justi, Prašek, King and Thompson, are given in Table 2.

7. Poebel (1938, a), p.139.

	Old-Persian	Elamite	Babylonian
1.	Adukan(a)isa	Hadukannas	Nīsannu
2.	Turauāhra	Turmar	Aiiaru
3.	Tāigarcis	Sākurrisis	Simannu
4.	Garmapada	Karmabadas	Du'ūzu
5.	.....	Turnabaṣis	Ābu
6.	.....	Qarbasi(ia)s	Ulūlu
7.	Bāgaiādis	Bagiiātis	Tasrītu
8.	.....	Marqasanas	Arahsamna
9.	A(ṣr)iiādiia	Hassiiāti(ia)s	Kislīmu
10.	Anāmaka	Hanāmakas	Tebētu
11.	.....	Samimas	Sabātu
12.	Uiiakna	Mi(ia)kannās	Addāru

The importance of the above table, in which Poebel's own transliteration has been used, lies not only in the sequence of the Old-Persian months but also in the order and completeness of the Elamite months: prior to the Persepolis descoveries, only nine of the months were known from the Bīsutūn inscription. The parallel sequences of Old-Persian, Achaemenid-Elamite, Jewish and Babylonian months are given in Table 3; this is useful in relating the months to the seasons.

It is apparent from Poebel's table above and from Table 3 that the names of the Iranian months are closely related to those of the Elamite months; they do, however, differ from the Avestān months (1). Stronach (2) has recently demonstrated that the Elamites had settled on the Marv-Dasht plain (the area in which Persepolis is located) before the Persian tribes (3). In view of the similarity to the Elamite months and the Persians' adoption of the Babylonian system of time-reckoning, it is possible that the latter itself occurred via the Elamites (4).

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1. Cf. Nadershah (1900), pp.252, 254.

2. Stronach (1974), p.247; see also Olmstead (1970), p.16; Frye (1976), p.11.

3. See Taqīzādeh (1317 H.S.), p.112.

4. See Taqīzādeh (1938), p.13; (1346 H.S.), p.64.

As mentioned in I.IV, intercalation of an extra month (either Ululu orAddaru) was not standardized in the Babylonian 19-year cycle until the year 367 B.C. (1). Until comparatively recently, many scholars even supposed that an octaeteris, or eight-year cycle, was in use in Babylon between 529 and 504 B.C. (2). While nine intercalary months are indeed attested in contemporary documents during this period of 25 years, these are within the framework of a 19-year cyle (3). Until all the intercalary months in the period between 747 B.C. and 367 B.C. are known, the question of the Babylonian and Iranian calendars cannot be solved conclusively (4). In the first six 19-year cycles, beginning from 747 B.C. and lasting until the first year of the seventh cycle (633 B.C.), only one intercalary month is attested for each cycle (5); in the seventh cycle only four intercalary months are attested; according to Parker and Dubberstein, an intercalary month of Ululu II in the year 622 B.C. is "very probable"(6). From the eighth cycle, beginning in the year 614 B.C., until the 13th cycle, beginning in 519 B.C., four cycles have, as expected, seven intercalary months (either Ululu or Addaru); the exceptions are the eighth cycle, in which seven intercalary months are attested and in which there should be an Ululu II in the year 614 B.C., and the tenth cycle, beginning in 576 B.C., in which only six intercalary months are known (7).

Let us consider the period in which reliable Iranian documents are dated by the Babylonian 19-year cycle. None of the events of Darius' Bīsutūn inscription is dated in an intercalary month. During the 50 years between 508 and 459 B.C., covered by the Persepolis Tablets, at least 18 intercalary months are required to "tie" the lunar months to the seasons, but only nine intercalary months are known from the Persepolis Tablets (8); four others are attested in Babylonian texts (9); Parker and Dubberstein have calculated the

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1. See above, Section I.IV.

2. See Fotheringham (1919), p.179; (1931), p.736.

3. See Parker and Dubberstein (1946), p.1, n.1.

4. See Parker and Dubberstein (1946), pp.3, 4, n.9[a]; Olmstead (1938, b), p.393.

5. Parker and Dubberstein (1946), p.3.

6. Parker and Dubberstein (1946), p.7.

7. See Parker and Dubberstein (1946), p.3 and Plate 1 facing p.4. For additional information relating to the intercalary months in the above-mentioned four cycles, see Goetze (1944), p.43 and footnote 8; also Wiseman (1960), p.75.

8. See Cameron (1948), p.34; (1965), p.182.

9. Parker and Dubberstein (1946), pp.6-7.

remaining intercalary months with some degree of certainty (1). Since the publication of their findings, additional information has been made available by Cameron: tablet 19 is said to indicate an Ululu II in the 30th year of Darius I. In Parker and Dubberstein's "Babylonian chronology"(2), a second Addaru for the preceding year is thought "probable", and an Ululu II in the 30th year "possible". Most of the intercalary months during the 16th, 17th, 18th and 19th cycles have yet to be determined: in fact, only one intercalary month is known from the 19th cycle. Our knowledge of the Babylonian calendar for the period in which it was in common use in Babylon and Iran is inadequate with regard to the intercalary months. From the year 367 B.C., the beginning of the 21st cycle, when the Babylonian astronomer Kidinnu revised the Babylonian 19-year cycle (3), the years 3, 6, 8, 11, 14, 17 and 19 were embolismic years; apart from year 17, in which a second Ululu was intercalated, it was the month Addaru which was repeated.

It is doubtful whether any other calendar existed in the Achaemenid period. Taqīzādeh's belief in the existence of other supposed Iranian methods of time-reckoning for that period is self-contradictory. He asserts that, in addition to the Egyptian calendar which was in use at that time, there were other calendars in use in Iran, or among the Iranians, "of which we know three with different degrees of certainty. The expressions 'certain', 'most probable', 'probable', and 'conjectural' may be used for the different grades of evidence in the following theories"(4). Taqīzādeh only employs the word "certain" in two statements concerning the Babylonian lunisolar system of time-reckoning; in the same paragraph, immediately after his definition of degrees of historical probability, he uses other terms, such as "presumably" and "may have been used", which are not included in his definition. Taqīzādeh pours doubts on his claims to such an extent that these occur repeatedly almost on alternate lines (5). Besides Taqīzādeh, many scholars (6), especially the pioneers, who only had knowledge of the

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1. See Cameron (1965), pp.181-182, Tablet 19.

2. At the time of writing, it has proved impossible to consult the latest edition of Parker and Dubberstein's Babylonian Chronology 626 B.C.-A.D.75 (Brown University Studies, XIX), 1956.

3. See Section I.IV.

4. Taqīzādeh (1952), p.604; (1346 H.S.), p.395; cf. Taqīzādeh's earlier works (1938), p.4; (1346 H.S.), p.95.

5. Taqīzādeh (1952), p.604; (1346 H.S.), pp.295-296.

6. The following scholars, at one time or another, believed that the Achaemenid official or religious calendar was the Young Avestan calendar of Egyptian origin. Fréret (1753), Bailly (1781), Gilbert (1792), Drouin (1892), von Gutschmid (1892), West (1897), Marquart (1909), Cavaignac (1923), Taqīzādeh (1952), Mu'īn (1325 H.S.). Taqīzādeh's works are still respected by Iranian scholars, who believe that Darius I adopted the Egyptian calendar as his official Achaemenian administrative cycle. Many Iranian authors share this belief, e.g. a recent official publication (Gāhnāma-Rūz Yikum-i Farvardīn-Nawrūz) produces further "evidence" in support of Taqīzādeh's theory; see Gurgānī (2535 Sh.), pp.19-20.

Bīsutūn inscription and were unacquainted with the Persepolis Tablets (discovered since 1933), attributed other systems of time-reckoning to Achaemenian Iran. They extended the calendars of later centuries back to the Achaemenid period by reverse extrapolation (1). Taqīzādeh, who was under the influence of these distinguished pioneers, developed a theory which was intended to reconcile the Egyptian and Babylonian methods of time-reckoning in the Achaemenid period. He claims that the Babylonian calendar was the official one and probably remained in use throughout the Achaemenian period, and that the Young Avestan calendar was of Egyptian origin (2) and was probably used among the Zoroastrians of Iran at that time, or at least after the first half of the fifth century B.C. (3).

If we return to the ritual objects, on which the year-dates appear to be by the same method as the dates on the Fortification and Treasury Tablets, i.e. by the Babylonian calendar (4), Taqīzādeh's solution no longer holds. The existence of other calendars in this period is not, of course, impossible: since at least four different religions, prior to or contemporary with Zoroastrianism, are mentioned (5), each religion may have had its own calendar. The early Iranian 365-day calendar discussed in Section II.I certainly remained in use in parts of Iran from early times down to the Parthian period, but there is no evidence of its use by the Achaemenids (6).

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1. Taqīzādeh (1952), p.604; (1346 H.S.), pp.395-396.

2. Ibid.

3. Ibid; see also Taqīzādeh (1349 H.S.), pp.199-200.

4. See above, p.40.

5. See Cameron (1948), p.9; Bowman (1970), p.15; Frye (1976), p.126.

6. See Section II.III.

II.III. Seleucid time-reckoning

The conquest of Iran by Alexander and the subsequent death of Darius III, the last Achaemenian king, in 330 B.C., brought to an end the glory of the Achaemenid dynasty in the ancient world. Alexander's Empire did not last long: the advent of the Arsacids (Parthians, Ashkānians) in 248/7 B.C. ended the domination of the Greeks and Macedonians in Iran (1); the country disintegrated into semi-independent "satrapies"(2). Greek colonies were established (3), populated by Greeks and Macedonians (4), together with the Arsacids themselves. The latter had originated from a semi-nomadic tribe (5) and adopted many features of Greek civilization (6) and administration; this resulted in the spread of Greek culture over Iran (7).

The Greeks and Macedonians, who in their homeland used to reckon the years from a fixed year, i.e. the first year of the first Olympiad, 776 B.C. (8), or from the year of appointment of a new chief administrative official (9), continued after the conquest of Babylon by

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1. The Greeks, however, were able to hold Bactria for a further hundred years, but the city was eventually lost between 140-130 B.C. during an invasion by the Sacae tribe. See Rawlinson (1969), pp.91-93, 95-96; Herzfeld (1935), p.58.

2. Ṭabari (1352-1354 H.S.), pp.494-498; Ḥamza of Isfahan (1932), p.15; (1346 H.S.), p.41; Mas'ūdī (1344 H.S.), p.229; Ibn Nadīm (1970), pp.574-575; Ibn Athīr (1949 H.S.), p.46; Baihaqī (1324 H.S.), p.96; Rawlinson (1872), pp.30-31; Tarn (1930), pp.24 ff.; Rawlinson (1969), p.130.

3. Rawlinson (1969), pp.37-38; Iliffe (1953), p.20; Ghirshman (1349 H.S.), pp.261-262.

4. Rawlinson (1872), p.45-60; Rawlinson (1969), pp.45, 54; Herzfeld (1935), p.58; Tarn (1951), pp.5, 8, 11, 13 ff.; Ghirshman (1949), p.316.

5. Rawlinson (1872), pp.17-26, 43; Unvala (1914), pp.1-2; Rawlinson (1969), pp.87-88; Debevoise (1938), pp. xli, 2; Iliffe(1953), pp.23, 26; Wolski (1956-1958), p.46; Ghirshman (1349 H.S.), pp.311-315.

6. See Unvala (1914), p.2; Frye (1976), pp.190-191; Frumkin (1970), pp.141, 144, 145, 152.

7. See Ghirshman (1349 H.S.), pp.315-318.

8. Nicolas (1833), pp.1, 2; Smith (195), pp.203-204; Pannekoek (1961), p.107.

9. Kobel (1908), pp.8-9; Tarn (1951), pp.28, 64.

Seleucus I Nicator, to reckon from a fixed year, but not from the Olympiad.

Some scholars believe that Seleucus I Nicator based the new era on his successful conquest of Babylon (1), but there is no real evidence to this effect; historical sources indicate that the era appears to have been adopted by Antiochus I after the death of Seleucus I (2), with whom he had ruled jointly for many years, in order to avoid the confusion which would have attended strict adherence to regnal-year reckoning (see below).

As has been discussed in the previous section, before the arrival of Alexander, the Babylonians and Iranians among many other civilized communities employed accession-year reckoning (3). After the conquest of Babylon by Seleucus I Nicator, the Babylonians began to reckon the years from the year of accession of Seleucus I (4), from the first New Year's Day (1st Nisanu, corresponding to 3rd April, 311 B.C.)(5). The Seleucids had also been acquainted with this method of dating, but by the eponymous magistracy (from the appointment of a new chief administrative official), as was customary in Greek cities (6); it was from the Babylonians that they learned to reckon the years from the accession of Seleucus I - not from the Babylonian New Year's Day, but from their own New Year's Day in late summer or early autumn (1st Dios, probably corresponding to 1st October 312 B.C.)(7) (see below). Consequently, the Babylonian year-number is one less than the Seleucid in the period between the two New Year's Days concerned (8). On the other hand, assuming that the Macedonians and Babylonians used

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1. Tarn (1930,b), p.142.

2. Pannekoek (1961), p.52.

3. Section II.II.

4. Sharḥ-i Zīj-i Sulṭānī (Ethe 2237), fol.15a; Tarn (1932), p.576; Bickerman (1944), p.74; Parker and Dubberstein (1946), p.18, n.5; cf. Taqīzādeh (1940-1942), p.125 and (1346 H.S.), p.218, in which he states "the epoch of the era seems to be connected with the death of Alexander IV (Aegus)". The same statement can be found in Ginzel (1906), p.136; see also Boyle (1963), p.251, n.3.

5. Minns (1915), p.37; Olmstead (1937), p.4; Lewy (1944), p.201, n.40; Tarn (1951), pp.64; Parker and Dubberstein (1946), p.24, Table p.35; cf. Bihrūz (1331 H.S.), p.77; Tarn (1930,I), p.142; Simonetta (1966), p.18, n.1.

6. Tarn (1951), p.64; Pannekoek (1961), p.107.

7. Bickerman (1944), p.74 and footnote 7; Tarn (1951), p.47, n.2; Parker and Dubberstein (1946), p.18; Tarn (1930,b), p.142.

8. Ginzel (1906), p.137.

the same intercalation system, two equivalent dates would be identical between 1st Nisanu and the Macedonian New Year.

After the death of Seleucus I in the 32nd year of his reign (280 B.C.)(1), his son Antiochus, who had been co-regent with his father since 292 B.C. (2), continued to reign alone; the Babylonians, as well as the Seleucids, continued to reckon the years from the accession of Seleucus I (3), as mentioned earlier. This system continued for more than half a century; as experience proved it to be a better system of dating (4), it was soon adopted thorughout Western Asia (5).

A good many contemporary Babylonian texts show that the Babylonians inserted intercalary months in the framework of their 19-year cycle, which they had regularized in 367 B.C. (see previous section). We shall refer separately to the Babylonian Seleucid era (311 B.C.), to differentiate it from the Seleucid era used by other communities; this year was the last year of the 23rd Babylonian intercalary cycle and included a second Addaru (6). According to Babylonian calculations, the month Addaru II was the intercalary month in years 1, 4, 7, 9, 12 and 15, and the month Ululu II in year 18, of the first cycle of the Babylonian Seleucid era. In the second cycle, which began in year 20 of the era, years 20, 23, 26, 28, 31, 34 and 37 were embolismic years, in which an Addaru II was added, except for the year 34, in which Ululu II was intercalary (7). This system continued to be used at least until A.D.75, the date of the latest available contemporary evidence (Babylonian astronomical tablets)(8).

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1. Herzfeld (1933), p.135.

2. See Welles (1934), 35-37; Olmstead (1937), p.6; Bickerman (1944), p.73; Wolski (1957-1958), p.34.

3. See Herzfeld (1933), p.135; Olmstead (1937), pp.6-8; Bickerman (1944), p.73; Parker and Dubberstein (1946), p.18; Tarn (1951), p.56.

4. Cf. Minns (1915), p.33; Bickerman (1944), pp.73, 74, 76; (1969), p.25.

5. Ginzel (1906), p.136; Tarn (1951), p.64.

6. See Neugebauer (1948), pp.210-211; (195?,I), p.33 Table L; Parker and Dubberstein (1946), Plate 1 and table p.35 ff.

7. See Neugebauer (1947), pp.146-147; (1948), pp.210-212; (195?,I), p.33; Pannekoek (1961), p.25.

8. See Neugebauer (195?,I), p.9-10, n.44, according to whom the latest date known from a cuneiform text is an almanac for A.D.75 (Dropie College, Philadelphia, U.S.A., to be published shortly by Sachs and Schaumberger); see also Bickerman (1969), p.25. Cf. Frye (1962), p.143.

On the Dura Europos parchments, the Seleucid era is referred to as the "former era" (1) and is used with Macedonian (2) and, occasionally, Babylonian month-names (3); the question of the intercalary months in the Macedonian calendar has not yet been solved (4). The Macedonians, who were well-acquainted with lunisolar time-reckoning, their local time-reckoning in fact being a lunisolar system (5) employing a framework of a 25-year cycle with nine intercalary months (6), may have made their calendar more accurate by adopting the Babylonian 19-year cycle (7). Even if this were so, the autonomous nature of their satrapies, which minted their own currency and became independent one after another, implies that separate consideration must be given to the methods of time-reckoning of each (8).

The Seleucid era was in use in various parts of Iran during the Seleucid and Arsacid period on the coins and civil documents of these dynasties. The Arsacids directly adopted the Seleucid era for their coins and probably for their official documents. All the wording inscribed on the coins (9), including the Macedonian month-names, appears in Greek (10), the "lingua franca" of the period (11). If it is reasonable to assume that the Arsacids adopted their method of dating directly from the Macedonians (12) (probably from one of the

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1. Welles et al. (1959), parchments Nos. 18, 19, 20, pp.98-116; see also Tarn (1951), p.65.

2. Welles et al. (1959), pp.102, 116, 130.

3. Ibid, p.148.

4. Bickerman (1944), p.74; (1969), p.25; Welles (1959), p.10.

5. Tarn (1951), p.64.

6. Bickerman (1969), p.38; Encyclopaedia Britannica (15th edition), Vol. 3, p.595.

7. Bickerman (1944), p.73.

8. See Bickerman (1969), p.25.

9. Tarn (1932), pp.592 ff.; Wroth (1964), pp.lxv-lxvii; Unvala (1914), p.9.

10. See Wroth (1964), pp. xxviii ff.; Unvala (1914), pp.2-3; Iliffe (1953), p.20.

11. Tarn (1951), pp.62-63.

12. See Wroth (1964), p. lxv; Tarn (1932), p.295; cf. Unvala (1914), p.8; Pīrnīyā (1344 H.S.), p.2683.

Greek satrapies in Eastern Iran, e.g. Hyrcania or Bactria where the Macedonian form of calendar was used), their method must have been that of the Seleucids rather than the Babylonian system (1). According to Wroth, "The Era employed (on Arsacid coins) is the Seleucid, dating from the autumn of 312 B.C."(2). Among the extensive collection of Arsacid coins in the British Museum, relating to nearly 450 years of Arsacid rule, probably only one date inscribed on one of the coins is by the Arsacid era (3) (see Section II.IV). Wroth states that "the place in the year assigned to the intercalary month is not known, but the most convenient hypothesis seems to be to assume that it was at the end of the year."(4). There is no reliable source for the starting point and system of intercalation of the Macedonian Seleucid era (5), as used during the Arsacid period; Wroth's hypothesis is the only plausible solution to this still-unresolved question (6). On the other hand, Bickerman (7) and Debevoise (8), amongst others, believe that the Arsacids in fact adopted the Babylonian Seleucid era, rather than the original Seleucid era.

Let us consider the question of which era the Arsacids adopted, first in relation to contemporary sources, and secondly by tracing the relics of the Seleucid era as they appear in Iranian literature, astronomical books and ephemerides (almanacs).

Greek dominance did not last long enough to change the language of the Iranian people (9). The main reason for using the Seleucid era and Macedonian month-names, together with Greek wording, on Arsacid coinage, was to facilitate comprehension by the Greek-speaking people. On their coins, the Arsacids did not even use their own Arsacid era, nor their own official language, which was probably Pahlavi. The

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1. According to Tarn ((1951), p.47, n.2; (1932), pp.574-575) "Bactria and other Macedonian colonies in Asia reckoned the Seleucid era from autumn 312 B.C." Arsaces, the founder of the Parthian dynasty, who lived in Bactria for some years, must have been acquainted with this method of time-reckoning before he became King of Parthia; see Report of the Calendar Committee (1955), pp.228-229.

2. Wroth (1964), p.lxv; see also Sellwood (1967), p.13, n.1.

3. Wroth (1964), p.21, n.3; cf. Pīrnīyā (1344 H.S.), p.2682.

4. Wroth (1964), p.lxvi.

5. Wroth (1964), p.lxvi; cf. Debevoise (1938), p.xxxv.

6. Cf. Lewy (1944), p.199, n.27.

7. Bickerman (1944), p.81.

8. Debevoise (1938), p.xxc.

9. See Ṭabarī (1352-1354 H.S.), p.498; Ghirshman (1349 H.S.), p.283; Lozinski (1959), p.17.

combination of Greek inscriptions and dates represented by Greek characters leaves no doubt that the method of dating on Arsacid coins is by the original Macedonian Seleucid era, reckoned from the autumn of the year 312 B.C. (1).

The single Pahlavi parchment from Avroman in Kurdistan is dated by an unspecified era; because of the partial obliteration of the figures of the date, it has received a variety of interpretations (2). In view of the attendant degree of uncertainty, there is nothing to be gained by discussing this parchment here (see Section II.IV). The two other Avroman parchments, I and II, which were discovered together with parchment III in a cave in a mountain called Kūh-i Sāvān, carry Greek inscriptions (3); the method of dating is entirely different from that on parchment III and again the era is not specified. Although the dating on these two parchments is "king-style", (see Section II.IV), the name of the king appearing on both as "Arsaces" which was the throne-name of nearly all the Arsacid kings as well as the name of the dynasty (4), it is not possible to determine precisely what era was used. Minns (5) is of the opinion that the dates belong to the Seleucid era, reckoned from 1st Dios 312 B.C.; this is supported by the fact that the month-names on parchments II and III are Macedonian (6) and the method of dating is almost the same as that on Arsacid coins. As regards the Pahlavi parchment, on which the month-name mentioned is in Pahlavi "Arotat" or "Harvatāt"(7), the name of the third month of the year and also of the sixth day of the month in the modern Zoroastrian calendar (see Tables 1 and 4), Cowley believes that it is nevertheless dated by the Seleucid era (8). In the light of double-dated documents of Dura Europos from the Arsacid period, on which the dates are undoubtedly Seleucid and Arsacid, both dates being reckoned from the autumn, which was the season of the starting point

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1. See Parker and Dubberstein (1946), p.18.

2. See Minns (1915), pp.22-23; Cowley (1919), pp.147-154; Unvala (1920), p.136; Sayce (1919), p.203; Rostovtzeff and Welles (1931), p.41; Tarn (1932), p.592; Yarshater (1336 H.S.), p.24, n.2; Simonetta (1966), p.20, n.1. See also Section II.IV.

3. Minns (1915), pp.23-33.

4. Rostovtzeff and Welles (1931), p.8; see also Tarn (1932), pp.574-575; Debevoise (1938), p.47; Lozinski (1959).

5. See Minns (1915), pp.31-32; see also Rostovtzeff and Welles (1931), p.41.

6. Cf. Debevoise (1938), p.26, n.114.

7. See Cowley (1919), p.148; Sayce (1919), p.203; Unvala (1920), p.137; Bickerman (1967), p.204.

8. Cowley (1919), p.152.

of the Seleucid era in 312 B.C. and of the Arsacid era in 248 B.C.(1), it seems reasonable to suppose that, if the Avroman parchments are dated by the Seleucid era, the starting point is the same as on the Dura Europos documents and the Arsacid coins, i.e. autumn 312 B.C., and not spring 311 B.C., which is the Seleucid era as reckoned by the Babylonians (2). The Dura Europos parchments, which are the most important evidence connected with the Arsacid era, will be considered in the next section. As far as can be ascertained from contemporary sources, e.g. the Avroman and Dura Europos parchments, and Arsacid coins, the Seleucid era, undoubtedly with an autumn starting-point in 312 B.C., was in common use in Iran during the Seleucid and Arsacid periods. It follows from the evidence constituted by the double-dated documents and Arsacid coins that the establishment of the Arsacid era reckoning the years both with the Macedonian and Zoroastrian calendars (see Sections II.IV-III.I and III.II) did not completely replace the Seleucid era until the fall of the Arsacid dynasty or even later (3).

Bypassing the Sasanian period, for which very little relevant evidence is available, let us now consider the Seleucid era as recorded by Iranian astronomers from the ninth and tenth centuries A.D. onwards. These took the name of Alexander (Iranian "Iskandar") or his epithet Dhu'l-Qarnayn" (two-horned), for the name of the Seleucid era (4). The naming of the Seleucid era after Iskandar does not imply a connection with the beginning of the reign of Alexander the Great or with his death, or with the death of Alexander IV Aegus (5). As a result of Roman dominance, the Iranians at that time mistakenly regarded all Europeans as Romans (just as later Iranians came to regard them as "Frangī", Franks); Iranian astronomers and historians consequently tended to call Alexander "Iskandar-i Rūmī" (Alexander the Roman)(6). This mistake, combined with the common practice of astronomers of calculating Ante Christum dates by the Julian calendar, often leads to the even more serious error of combining the Julian calendar with the Seleucid era, calling it the Roman era or Alexander era (Tārīkh-i Rūmī or Tārīkh-i Iskandarī).

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1. Welles et al. (1959), pp.10, 102, 108, 116.

2. Rostovtzeff and Welles (1931), p.39; Welles (1934), p.302; (1959), p.6.

3. See Herzfeld (1933), p.136; Simonetta (1956), p.79. See also Section II.IV. Cf. Boyce (1970), p.516.

4. See Ginzel (1906), pp.263-264; Taqīzādeh (1940-1942), pp. 124-125; (1346 H.S.), p.216; Sarton (1959), p.326.

5. See below, pp. 60 ff, 64,n.4.

6. See Williams Jackson (1906), p.354; Herzfeld (1933), p.133; (1935), p.52; West (1880), pp.xii, 151, n.2.

Iranian astronomers and historians of the ninth and tenth centuries are unanimous in locating the starting point of the Alexander era at 1st Tishrin 312 B.C. (see Table 4). This date is, in fact, the epoch of the Macedonian Seleucid era. The Iranian astronomers calculated the date from 1st Tishrin (Dios; see Table 4), corresponding to October, known to the Iranians as the first month of autumn. The year and month indicate that Iranian authors adopted the Macedonian era with an autumn starting point, as used during the Seleucid and Arsacid periods, and that this must have survived in some form over the ages.

Khwārazmī (died c.863) and Abū Ma'shar (A.D.787-887), two Iranian mathematicians and astronomers, whose works are frequently quoted by Bīrūnī (1), both discuss the Alexander era, i.e. Seleucid era, and give the interval in years, months and days between the starting points of the Alexander era and several other well-known eras. According to Ibn al-Muthannā (tenth century A.D.), who comments on the astronomical tables of Khwārazmī in question-and-answer form, Khwārazmī placed the first day of the Seleucid era on Monday 1st Tishrin, 932 years and 287 days before the first day of the Hijra era (16 July A.D.622), i.e. 340,700 days (2). The same result can be arrived at from the figures given by Abū Ma'shar, though these need further explanation: according to Bīrūnī, Abū Ma'shar made the interval between the era of the Flood (1,359,974 days before the Hijra era) and the Alexander era 2,790 years, 7 months and 26 days (3). Al-Hāshimī, admitting that he used Abū Ma'shar's tables (4), made this interval (2,792 x 365)+ 194 ≒ 1,019,274 days (5). One must therefore read Abū Ma'shar's figure given by Bīrūnī for days (26) as 16, to reach the total number of days, 1,019,274, which is the same result as that obtained by al-Hāshimī (6). If we subtract the number of days between the era of the Flood and the Hijra era (1,359,974 - 1,019,274 ≒ 340,700), the result will be the same as that obtained from al-Muthannā's commentary on the astronomical tables of Khwārazmī.

Problems arise concerning the conversion of this figure to the Christian era and the determination of the day, month and year of the Ante Christum period on which the Seleucid era has been located by Iranian astronomers. Before considering these problems, let us first examine the accounts of two Iranian historians from the centuries under review.

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1. Bīrūnī (1879), e.g. pp.27-31, 94-96, 136, 187.

2. Ibn al-Muthannā (1967), pp.18-19.

3. Bīrūnī (1879), p.29; (1352 H.S.), pp.39-40.

4. Pingree (1965), pp.2, 4.

5. Pingree (1968), p.39.

6. Pingree ((1968), p.39) has already made this correction.

Ḥamza of Isfahan (1), quoting unnamed astronomers, gives the interval between the Alexander era and the Hijra era as 340,901 days. He places the epoch of the era of Alexander on Monday, 1st Tishrin, and the epoch of the Hijra era on a Thursday; he reckons 340,901 days as being equivalent to 961 lunar years and 154 days, which, when converted into Chaldean units (2), i.e. solar years (according to Ḥamza, each year being of $365\frac{1}{4}$ days), amounts to 932 years and 289 days. The errors in this statement can be explained by considering Ḥamza's first figure, the number of days, in relation to the day of the week at the start of each era: the weekdays do not agree with the figure given; neither is the number of days equal to 961 lunar years and 154 days or to 932 Chaldean years and 289 days. The number of days should have been obtained from the value of 961 lunar years plus 154 days, with which, as a Moslem historian, he should have been more familiar, i.e. $(961 \times 354\frac{11}{30}) + 154 = 340,700$ days.

Mas'ūdī gives the time-interval between the Alexander era and Yazdgirdī era as 942 Roman years and 259 days. The interval between the Yazdgirdī era and the Hijra era is calculated by Mas'ūdī as 3624 days (3), (see Section IV.I), making that between the Alexander and Hijra eras $((942 \times 365\frac{1}{4}) + 259) - 3,624 = 340,700$ days (4).

It is evident from the above that the Iranian astronomers and historians of the ninth and tenth centuries A.D., whose work is much quoted by Iranian authors of later centuries up to the 20th, used a unique source, calculating the dates backwards from either the Yazdgirdī or Hijra eras, with the inevitable attendant misunderstandings or mistakes by scribes. Fortunately, these are not of such a nature as to invalidate their conclusions, subject to minor corrections.

The most precise definition of the Alexander era can be found in the works of Bīrūnī, who was well acquainted with the sources quoted above and with many others. Regarding the time-interval between the era of the Flood and the Alexander era, Bīrūnī quotes Abū-Ma'shar whose computation, according to Bīrūnī, comes close to that of the Christians, being 249 years and 3 months less than the estimate common amongst astronomers up to that time (5). It is apparent from Bīrūnī's statements that the discrepancy stems from divergent opinions concerning the era of the Flood and the era of the Creation, rather than the Alexander era (6). The time-interval between the latter

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1. Ḥamza of Isfahan (1932), pp.8-9; (1346 H.S.), p.14.

2. No evidence can be found of a $365\frac{1}{4}$-day calendar among the Babylonians. Furthermore, the term "Chaldaean" is used by Hamza and other Iranian historians and astronomers in a rather vague and confused manner; see also Bīrūnī (1879), p.100; (1352 H.S.), p.128.

3. Mas'ūdī (1344 H.S.), p.548.

4. Ibid.

5. Bīrūnī (1879), p.17; (1352 H.S.), pp.24-25.

6. Ibid.

and the Hijra era can be derived from Bīrūnī's works al-Tafhīm (1) and al-Āthār al-Bāqīya (2); it is identical to that obtained from Abū M'shar and other sources quoted above. Taqīzādeh (3) unfairly accuses Bīrūnī of ignorance in this particular matter in his outstanding work al-Āthār al-Bāqīya. On the contrary, Bīrūnī gives a comprehensive, and for the most part completely accurate, account of the era of Alexander. In al-Āthār al-Bāqīya he states that the Iranians and Greeks disagreed over the time-interval "between Alexander" and the reign of Yazdgird; he then gives the Iranian version of the number of days "from Alexander" till the reign of Yazdgird, which incidentally agrees with that obtained from the above-mentioned sources. The occasional discrepancy of one or two days in this work by Bīrūnī arises from the method of calculation he used, which will be discussed in Section IV.I. in relation to the Yazdgirdī era.

Bīrūnī explains several other eras associated with Alexander: for example (4), "the era of Philip the father (sic) of Alexander, is based upon Egyptian years, but this era is also frequently dated from the death of Alexander the Macedonian, the founder. In both cases the matter is the same, and there is only a difference in the expression. Because Alexander the founder was succeeded by Philip, therefore, it is the same, whether you date from the death of the former or the accession of the latter, the epoch being a connecting link common to both of them"(5). There has obviously been a mistake, either by Bīrūnī or by the scribe employed, concerning the relationship between Alexander and his brother Philip. Sachau has added a corrective annotation to this effect at the end of the English edition of al-Āthār al-Bāqīya (6) without drawing attention to the note in the text itself. The mistake consequently appears in the Persian translation of al-Āthār al-Bāqīya (7) without comment.

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1. Bīrūnī (1934), pp.174-175; (1316-1318 H.S.), pp.239-241.

2. Bīrūnī (1879), p.133; (1352 H.S.), table between pp.40 and 41.

3. See Taqīzādeh (1940-1942), p.129, n.1; (1346 H.S.), p.224, n.1; (1317 H.S.), pp.30-38, n.68, 239, 240; see also Boyle (1963), p.251, n.3; cf. Herzfeld (1933), pp.135-136. Taqīzādeh ((1940-1942), pp.129-130) believed that Bīrūnī subsequently corrected his "mistake". He must not have been aware of the existence of identical tables in Bīrūnī's earlier and later works.

4. Bīrūnī (1879), p.32.

5. Bīrūnī (1879), p.32; (1352 H.S.), p.45.

6. Bīrūnī (1879), p.376.

7. Bīrūnī (1352 H.S.), p.45.

In the same passage, Bīrūnī describes the adoption of the Alexander era by the Jewish community in Jerusalem from the 27th year of Alexander's life, after his conquest of Jerusalem on his way to Iran. He does not state that this Jewish version of the era was used by the Iranians, although he does say that the era was adopted by the Jews and Greeks after the first millennium of Moses. Since Bīrūnī, who gives the dates of many events by the Alexander era and of course knew of its use by Iranian authors (1), never mentions that the Jewish-style era was in use among the Iranians, there can be no doubt that the Alexander era in use among the Iranians was not the same as the Jewish and did not have the same starting point.

If one were unaware of Bīrūnī's allusions to divergent opinions on the identity of the true Alexander and on the Alexander era itself, spread over his works, and if no attention is paid to the many dates given by him by this era, criticism based solely on his specific description of the Alexander era (2) will inevitably be unfounded.

In al-Tafhīm, Bīrūnī states that "(the era) of the people of the book is the Greek one known as the Alexander era, although it is from the beginning of the year when Seleucus was appointed King of Antioch. Christians employ in it Syrian or Greek years, while the Jews use their own lunar years with the necessary intercalations, and the Harranians, who called themselves Sābians, have customs similar to the Jewish."(3). Like Bīrūnī's "al-Tafhīm", in general, this precise and comprehensive definition has unfortunately received scant attention from scholars working in this field (4).

There is no additional first-hand information on the Alexander era in Iranian literature either before or after the 10th and 11th centuries. In astronomical tables and historical works, the Alexander era is generally placed 12 years after Alexander's death, i.e. 340,700 days before the era of Hijra (5), the method of time-reckoning being the Julian calendar with Syrian month-names (see Table 4, which also gives the Macedonian months which were in use earlier in the Arsacid period).

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1. Bīrūnī (1879), p.122; (1352 H.S.), pp.163-164.

2. Bīrūnī (1879), pp.32-33.

3. Bīrūnī (1934), p.172; (1316-1318 H.S.), p.237.

4. The incorrect association of the era of Alexander with Alexander IV (Aegus) was first proposed by Ginzel ((1906), p.136). Taqīzādeh enlarges on the theory but makes no reference to the remarkably similar passages in Ginzel. See also Lewy (1944), p.199, n.25; Boyce (1970), pp.537-538; Bihrūz (1331 H.S.), pp.88-93.

5. See, for example, Kūshyār, cited in Ideler (1926), p.625-627; Naṣīr al-Dīn Ṭūsī (O.2(7)), fol.14^{b}. Ulugh Beg (1847), p.300, 307; Bīrjandī (Ethe 2237), folios 15^{a}-17^{a}, 19^{b}-23^{a}; Mullā Muẓaffar (1297), Bāb 2nd.

Iranian astronomers and historians believe that the Seleucid era, which they refer to as the Iskandarī or Rūmī, or occasionally as the Dhū'l-Qarnayn era, began on Monday, 1st Tishrin, corresponding to 1st October 312 B.C., i.e. 340,700 days before the Hijra era. The adoption of the Alexander era by the Jewish community of Jerusalem is described by Bīrūnī (1), but his description is repeated with slight modification by authors of later centuries. According to Bīrūnī, Alexander ordered the Jewish community of Jerusalem to abandon the era of Moses and David and to adopt his era from the 27th year of his life. The Jews obeyed his command, since the Rabbis permitted such a change at the end of each millenium after Moses. They therefore adopted the Alexander era from the 26th year of his life, which happened to coincide with the end of a millenium. The same story is related by many other Irnaian authors (2), but they place the era 12 solar years after the death of Alexander, and they claim that the Jewish Rabbis promised Alexander that they would adopt his era, but not until the end of the millenium, which (as it turned out) would be 12 years after Alexander's death. Nevertheless Iranian authors of later centuries, while erroneously combining the Seleucid and Jewish Alexander eras, which as Bīrūnī explained had a difference of nearly 20 years, still continued to give the same time-interval between the Alexander and Hijra eras, namely 340,700 days (3).

The conversion of dates will be dealt with in Chapter V. However, since the correspondences between Christian (Julian) and Alexander-era dates given by modern authors are almost invariably incorrect and have led to general confusion regarding the Alexander era itself, a brief explanation is called for. The discrepancy between the corresponding Ante Christum date which these authors give and the true Alexander-era date is exactly one year, for which there are two possible explanations:

(a) If we wish to convert, say, the third year of the Alexander era, reckoned from 312 B.C., subtraction will give 312 - 3 = 309 B.C.; simple counting, on the other hand, gives the third year as 310 B.C. Overlooking the first year of the era being converted is not so easily detected when longer periods are concerned. The above-quoted Iranian authors have calculated the Alexander era as 311 B.C., exactly one year earlier than the true date.

(b) Astronomers calculate the interval between two events before and after an era by subtracting one year from the number of years before the era in question (see Chapter V). This being the case, where sources give the number of years, months and days for the interval between the Alexander era and the Hijra or Yazdgirdī era, there is no need to subtract a year from the total given above. The corresponding date for the Alexander era given by Pingree in "The Thousands of Abū-Ma'shar"(4) and by Ramsay Wright in "The Book of Instruction in the Elements of the Art of Astrology"(5) should consequently read 312 B.C. instead of 311 B.C.

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1. Bīrūnī (1879), pp.32-33; (1352 H.S.), pp.45-46.

2. See above, pp.60 ff.

3. See Pingree (1968), p.39.

4. Ibid.

5. Bīrūnī (1934), p.172.

II.IV. The Arsacid era

The Arsacids adopted an era for time-reckoning based on the beginning of the reign of the first king of the dynasty (1), as had been the case in the preceding Seleucid era, but the Arsacid era did not in fact become generally used during the actual period of the Arsacid dynasty. The Arsacid kings themselves used the Seleucid era on their coins (2) and official documents (3) right up to the fall of the dynasty (4). The Arsacid era was also used in conjunction with the Zoroastrian calendar (see Section III.I). Since use of the era did not survive the end of the dynasty, information is limited to contemporary documents.

The earliest date employing the Arsacid era appears on a Babylonian document dated 68 A.E.(5), on which the corresponding date by the Seleucid era is also given (132 S.E., corresponding to 180/179 B.C.). The date 68A.E. indicates that the adoption of the Arsacid era by the Arsacids themselves cannot have been later than 68 A.E.(6). Since the Seleucid era was in common use (7) at the time of the advent of the Arsacids (8), it seems that the Arsacids, who adopted Greek and Macedonian culture (9), imitated the Seleucids by instituting their own dynasty-era (10) at an early stage (11). If we accept that the Arsacid era is the era of the Arsacid dynasty, its starting point at the date of the revolt or declaration of independence by Arsaces would correspond, according to the evidence, to the 65th year of the Babylonian Seleucid era (12), i.e. 247 B.C.(13). The year 247 B.C., however, is

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1. See Tarn (1951), pp.65, 359; Wolski (1957-1958), p.52; Abgarian and Sellwood (1971), p.116; cf. Bickerman (1944), p.80; Boyce (1970), p.516.

2. See Wroth (1964), pp.lxv-lxvii; Tarn (1932), p.592.

3. See Rostovtzeff and Welles (1931), pp.39-41; Welles (1934), pp.299-306; Welles et al. (1959), parchments Nos. 18, 19, 20, 22, 24;

4. See Wroth (1964), pp.238 ff.; Simonetta (1956), pp.77-82; cf. Boyce (1970), p.516.

5. See Minns (1915), pp.34-36; Olmstead (1937), p.10; cf. Tarn (1932), p.593; Bickerman (1944), p.80 and n.53 on same page.

6. See Minns (1915), p.36; cf. Tarn (1932), p.577, 593.

7. See Pannekoek (1961), p.52; Pīrnīyā (1344 H.S.), p.2683.

8. See Section II.III.

9. See Frye (1976), pp.199 ff.

10. See Tarn (1951), pp.65, 359; Bickerman (1944), p.80

11. See Tarn (1932), p.575; Abgarian and Sellwood(1971), p.116.

12. See Tarn (1932), pp.592-593; Parker and Dubberstein (1946), table, pp.37 ff.

13. See Rostovtzeff and Welles (1931), p.39; Olmstead (1937), p.13; Parker and Dubberstein (1946), p.37; Abgarian and Sellwood (1971), p.116.

three years later than the traditionally-accepted year for the beginning of the reign of Arsaces, founder of the dynasty in 250 B.C. Although this date is accepted by many distinguished scholars (1), the Arsacid era itself is the best evidence that the independent reign of Arsaces began in 247 B.C. Wolski studies the question of the year in which Arsaces seized the throne of Parthia and, unlike most authors, arrives at the same date (2), whereas Bickerman is of the opinion that Tiridates I antedated the first year of his reign (3) and that it was he who introduced Arsacid-era reckoning from 247/248 B.C. in the year 231 B.C., after his victory over Seleucus II near Asaac (4). Bickerman, in company with Lewy, denies that Arsaces was the founder of the Arsacid dynasty (5), supporting his hypothesis with the argument: "When a Hellenistic ruler succeeded in gaining the sovereignty...he often antedated the initial year of his kingship...the Arsacids followed the same patterns"(6). The parallel between the Hellenistic rulers and the Arsacids, who, according to Bickerman, imitated them by antedating their initial year (7), becomes difficult to accept in full when we read in the next paragraph of the same work that "The Arsacids used the Babylonian form of the calendar, the year starting in spring..."(8). Bickerman is, of course, not unaware of the two dates given by Eusebius (c. A.D.264-340) for the foundation of the Arsacid dynasty: the third year of the 132nd Olympiad, i.e. 250 B.C., and the 133rd Olympiad, i.e. 248-244 B.C. (without specifying which year of the Olympiad)(9). It is difficult to understand why Eusebius gave two dates for a single event, but, since the Arsacid era indisputably falls within the 133rd Olympiad, the year 250 B.C. is out of the question (10). Those who

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1. See Rawlinson (1872), p.44; Rawlinson (1969), p.56; Smith (1952), p.43; Herzfeld (1935), p.58.

2. Wolski (1956-1958), pp.35-52; see also Debevoise (1938), p.9, n.34; Abgarian and Sellwood (1971), pp.115-116.

3. Bickerman (1944), p.81.

4. Bickerman (1944), p.82; cf. Rawlinson (1872), p.49 "the victory of Tiridates over Seleucus II was regarded by the Parthians as the second beginning of their independence".

5. See Bickerman (1944), p.79; Lewy (1944), p.205; cf. Wolski (1956-1958), p.46, n.6; also p.52; Debevoise (1938), p.10; Dyakonov and Livshits (1960, b), p.38, Document No. 1760.

6. Bickerman (1944), p.81.

7. Cf. Wolski (1956-58), p.45; Pīrnīyā (1344 H.S.), p.2648; Report of the Calendar Committee (1955), p.178.

8. Bickerman (1944), p.80.

9. See Rawlinson (1872), p.44, n.5; Pīrnīyā (1344 H.S.), p.2202; Wolski (1956-1958), pp.37, 50, 51.

10. Cf. Rawlinson (1969), p.56; Williams Jackson (1925), p.40; Pīrnīyā (1344 H.S.), p.2202.

believe that 250 B.C. was the initial year of the independent reign of Arsaces and that Tiridates I succeeded his brother two years later also believe that Tiridates I introduced Arsacid-era reckoning from the beginning of his reign or his victory over Seleucus II. Contemporary sources indicate that the Arsacid dynasty was named after its founder and that the name of the founder of the dynasty, with very few exceptions, became the "crown-name" of succeeding kings. Since this implies veneration for the founder of the kingdom (1), it seems unlikely that Tiridates would have adopted the beginning of his own reign as the era (2) or would have in this way celebrated his own victory over Seleucus II (3), rather than his brother's revolt against Antiochus II (4). In the absence of documents dated by the Arsacid era from the first 68 years of the Arsacid dynasty, this hypothesis would be difficult to support, especially if one assumes that the era was introduced by a particular king in a particular year (5).

The dates on later contemporary documents are helpful in studying the method of time-reckoning by the Arsacid era, but here again we are faced with the same difficulties as when considering Achaemenid and Seleucid time-reckoning (6). Even in the light of the vast amount of Babylonian dated-documents, it is so far impossible to ascertain the exact nature of the Iranian and Macedonian versions of the Babylonian calendar (7). Certain scholars believe that the Iranian and Macedonian methods were identical to the Babylonian and that the intercalation of extra months followed a similar pattern (8). Although this hypothesis would facilitate study of the Iranian calendar, the dates on contemporary documents suggest that it is open

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1. Rawlinson (1872), pp.45, 46, n.1; Olmstead (1937), p.3; Pīrnīyā (1344 H.S.), pp.2197, 2675; Sellwood (1962), pp.73, 75; (1967), p.13.

2. Bickerman (1944), p.81.

3. Smith (1952), p.263.

4. Wolski (1956-1958), pp.37-43.

5. Bickerman claims that Tiridates I introduced the Arsacid era from 247/246 B.C. in the year 231 B.C. Not only does Bickerman give no reason for his two dates for the Arsacid era: he subsequently ((1969), p.126) gives a different pair of dates for the same era.

6. See Section II.II.

7. See Tarn (1951), pp.64-65; Wolski (1956-1958), p.36.

8. See Minns (1915), pp.34-36; Welles (1934), p.202 and n.8 on same page; Bellinger and Welles (1935), pp.142-143; Bickerman (1944), pp.73-44, 81; Tarn (1951), p.65; Neugebauer (195?), pp.7, 32-33.

to question (1). Babylonian documents dated by the Arsacid era are not sufficiently numerous to permit cast-iron conclusions to be drawn, but they are important not only for study of Babylonian dating by the Arsacid era, but also for study of the use of the Arsacid era in other parts of the Arsacid realm. The dates on Babylonian documents, which when dated by the Arsacid era are, without exception, double (2), i.e. by both the Arsacid and Seleucid eras, indicate that the Babylonians employed the Arsacid era together with their own calendar after that of the Seleucid era and corresponding to 14th April 247 B.C. Since the Babylonian intercalary 19-year cycle had not undergone any change (3), the month Addaru II was intercalated in years 2, 5, 8, 13, 16 and 19, and the month Ululu II in year 11 of the first 19 years of the Babylonian Arsacid era (4). The first year of the Arsacid era is the seventh year of the 27th Babylonian intercalary cycle.

Although there is no doubt that the Babylonian Arsacid era is reckoned from 1st Nisan 65 S.E., this does not necessarily imply that the Arsacids employed the Babylonian form of the calendar or that the epoch of the Arsacid era was 1st Nisan (beginning of the spring). Since the Arsacids used the Macedonian form of the calendar, with the year starting in the autumn, and with Macedonian months, it seems reasonable to assume that they used their own era in the same calendar form. The fact that the earliest date given by the Arsacid era, namely 68 A.E. (180/179 B.C.; 132 S.E.), is from the period before the occupation of Babylonia by the Arsacids would suggest that the adoption of the Arsacid era by the Arsacids was not in the Babylonian calendar form, with which they were not even acquainted before relationships between the two communities had developed.

It has been suggested that the date at the end of the stone-carved version of the letter from Artabanus II (c. A.D.12-38) to Seleucia (5) shows that the official era of the Arsacids began in spring (6), but there is no proof of this. The latter, which is a royal decree on a legal matter, carried five dates in the text, i.e. 329, 330, 331, 332 and (again) 332, all by the Seleucid era (7). The

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1. See Olmstead (1937), p.13; Parker and Dubberstein (1946), p.18; Neugebauer (195?), p.7; Sellwood (1967), p.13, n.1.

2. See Minns (1915), pp.34 ff.; Neugebauer (195?), p.33.

3. See Neugebauer (195?), p.33; Parker and Dubberstein (1946), pp.35 ff.

4. Reckoning the years from the Seleucid era (Babylonian-style), the years 1, 4, 7, 9, 12, 15, 18 and 20 will be embolismic.

5. See Welles (1934), pp.301-302.

6. Bickerman (1944), p.81, n.60; see also Report of the Calendar Committee (1955), p.177.

7. See Welles (1934), pp.301-302.

nature of the letter does not require a month-date. At the end of the letter the date is inscribed "17 Audynaios 268", which is by the Arsacid era. There is no indication that this date represents the date on which the carver completed his task, nor the date on which the city received the letter. There is no parallel between the Seleucid dates in the text itself and the Arsacid date at the end of the letter, but the fact that the Macedonian month-name was used in the Arsacid calendar indicates that Macedonian month-names were used with both eras, possibly in the same form and order, to avoid confusion between the two simultaneously employed dating systems. It is highly improbable that the Arsacids, who used Audynaios as the third month of the year in the Seleucid era, would have used the same month as the ninth month of the year (the starting point of the year in spring) in their own official calendar (1) (see Table 4).

The Dura Europos documents from the Arsacid period are the most important evidence in connection with the method of time-reckoning by the Arsacid era, as used in the Arsacid realm outside Babylonia. We intend to quote at length the dating part of two documents on which the dates are well-preserved, in order to illustrate the method of dating described as "king style" and the form of calendar in which the Arsacid era was used in the Arsacid realm.

Parchment No. 18 (2): In the reign of the King of Kings Arsaces, benefactor, just, manifest God, and friend of Greeks (3), in the year 334 "as the King of Kings reckons", but 398 of the "former era" on the 13th day of the month Panemos, in Europos...

Parchment No. 20 (4): In the reign of the King of Kings Arsaces, benefactor, just, manifest God, and friend of Greeks, in the year 368 "as the King of Kings reckons but 432 of the "former era", on the 26th day of the month Daisios, in the village Paliga (5)...

The phrases "as the King of Kings reckons" and "former era" refer to the Arsacid and Seleucid eras respectively (6). The date

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1. See Wroth (1964), pp.lxv-lxvii; also Tarn (1951), pp.64-65; Welles (1934), p.302.

2. See Welles et al. (1959), pp.98-104; also parchments Nos. 19, 22.

3. The same formula is used on two Avroman parchments, but not on the Pahlavi one; see Minns (1915), pp.31-32. See also Rostovtzeff and Welles (1931), pp.3 ff.

4. See Welles et al. (1959), pp.109-116.

5. For the location of the village Paliga, see Welles et al. (1959), p.111 and n. 12 on same page.

6. See Billinger and Welles (1935), p.142.

on each document agrees with the well-known 64-year difference between the two eras (1). It is generally accepted that the Macedonian Seleucid era began in autumn, 312 B.C. (see previous Section). The Arsacid era must have been reckoned from the same season of the year, 64 years later. This is supported by the absence in the Dura Europos parchments of the month-date for the Arsacid era, which indicates that the month-date in both dates, i.e. Seleucid and Arsacid, is the same. There is no doubt as to the authenticity of the documents, on which personal names and titles indicate that they are official documents of the satrapy of Dura Europos (2).

The difference of 65 years between the Seleucid and Arsacid eras, appearing on a few cuneiform tablets, is, according to Minns, probably due to mistakes (3), though some modern authors have been misled by the discrepancy (4). It is self-evident that the 65th year of the Macedonian Seleucid era and the 64th year of the Babylonian Seleucid era could both begin in 248 B.C. If one were to assume that the 65-year difference is due to the use of the Macedonian form of the calendar for Seleucid dates and the Babylonian form of the calendar for Arsacid dates, it would be apparent that the epoch of the Arsacid era could under no circumstances fall in 246 B.C., the date which appears in some modern works (5). There is no doubt that the corresponding date by the Arsacid era in the Macedonian form of the calendar is 248 B.C.(6). Consequently, the Macedonian year-number is greater by one than the Babylonian in the period between the Macedonian New Year's Day in autumn and Babylonian New Year's Day in spring.

In addition to the Seleucid and Arsacid eras, each with different starting points and intercalary systems, the Zoroastrian method of time-reckoning using the Arsacid era has also been employed on extant documents relating to the Arsacid dynasty.

Although we intend to deal with the Zoroastrian calendar separately in forthcoming sections, a briefer description of these documents and the geographical location of the finds will be helpful in ascertaining the precise date of the Pahlavi Avroman parchment, which we passed over, as far as dating was concerned, when considering the parchments as a whole (see above, p.59).

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1. See Welles et al. (1959), p.10; Ginzel (1906), p.136; Neugebauer (195?), pp.32-33; Parker and Dubberstein (1946), pp.37 ff; Simonetta (1966), pp.18-20.

2. See Welles et al. (1959), pp.6, 12, n.15, 111-113.

3. Minns (1915), p.37.

4. See Bickerman (1944), pp.80 ff.

5. Ibid.

6. See Ginzel (1906), p.138; Simonetta (1966), p.18.

In excavations at the forgotten city of Nisa, which was the Arsacid capital during the first two centuries B.C.(1), and which is located 18 kilometres south-west of Ashkabad ('Ishqābād) in what is now the Soviet Union, Soviet archaeologists have since 1948 (2) discovered more than 2800 ostraca (potsherds) (3) in a former royal wine-cellar. The language and wording of the ostraca have received various interpretations, particularly among Soviet scholars (4). According to Dyakonov and Livshits, the documents bear inscriptions in Aramaic characters but the Parthian language (5), whereas Vinnikov considers that "the language is actually Aramaic, but this does not rule out the possibility of there being, in this instance, some influence from the everyday speech of the Nisa scribes"(6). Dyakonov and Livshits both subsequently arrived at a different conclusion, maintaining that the characters were Pahlavi or pre-Pahlavi, and that the language was Parthian (7). According to these co-authors, there are three schools of thought with regard to the language and characters of the Nisa documents:

1. Aramaic characters and Aramaic language: Vinnikov; Segert; Tseledi (8).

2. Pre-Pahlavi characters but doubt about the language: Schnitser; Atheim; Kharmatta.

3. Pahlavi or pre-Pahlavi characters, but Parthian language: Dyakonov and Livshits; Henning; Yarshater (9).

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1. The early Arsacid capital was largely destroyed by an earthquake in A.D.454; see Pīrnīyā (1344 H.S.), pp.2642-2643; Isidore of Charax (1914), p.9; Frumkin (1970), p.143.

2. See Dyakonov and Livshits (1960, a), p.14; (1960, b), pp.5, 7; Livshits and Lukonin (1960), pp.158, n.22, 160; Frye (1976), p.204.

3. The Nisa documents are pieces of pottery which were used to keep records of wine deliveries and consumption. The inscriptions are in ink, in some cases on both sides, presumably to make the fullest use of the broken pieces; on occasions they have been erased and re-used. The irregularly-shaped fragments are generally roughly 20 cm. in size, but some pieces measure up to half a metre across.

4. See Frumkin (1970), pp.145-146; Henning (1953), p.134.

5. Dyakonov and Livshits (1960, a), pp.15, 22.

6. Vinnikov (1954), p.126.

7. Dyakonov and Livshits (1960, b), pp.8-13.

8. See also Bickerman (1966), p.15; (1967), p.204; cf. Encyclopaedia Britannica (15th edition), vol.3, p.605.

9. See also Yarshater (1336 H.S.), p.25, n.1; Frye (1976), p.204.

Although there is controversy about the language and characters of this group of documents, there can be no doubt that there is a relationship between the Nisa documents and Avroman parchment III with regard to their method of dating (see below).

According to Soviet scholars, almost all the Nisa documents, with the exception of No. 1760 (see below), deal with wine-growing, vintage, wine-making (1), vineyard-tax (paid "in kind" in the form of grapes, wine and vinegar)(2), or annual records of wine-weights (3). The format of the information varies little on the ostraca (4): when the information concerns the delivery of a vintage, the ostraca bear the name of the vineyard, estate, quantity, deliverer and date (5).

Most of the Nisa documents are dated by the year; only on a few are the Zoroastrian month and month-day given. The latter is a clear indication of the calendar in use. The earliest date on any of the documents is 97 A.E., corresponding to 151 B.C. (247 - 96 = 151)(6). According to Vinnikov, there is only one exceptionally early date: an ostracon discovered in 1951 is dated 75 A.E., equivalent to 172 B.C. (7). The latest date is 235 A.E. (13 B.C.)(8).

Soviet scholars have identified the era as the Arsacid era, the same Arsacid era as that used by Babylonian astronomers (see below), which began in 247 B.C. This view seems to be generally accepted (9),

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1. Dyakonov and Livshits (1960, a), pp.17-20; Vinnikov (1954), pp.115-116, n.2; see also Frye (1976), p.204; Frumkin (1970), p.145.

2. Dyakonov et al. (1953), pp.122, 128.

3. Dyakonov and Livshits (1960, a), p.17.

4. Ibid.

5. Dyakonov and Livshits (1960,a), p.17; see also Dyakonov and Livshits (1960,b), pp.120-121, giving a chronological list of published ostraca, together with details of the undated fragments. For information relating to the deliverer-names, place-names, location of vineyards and estates, see Dyakonov and Livshits (1960, a), pp.17-18, 21, 23-24; Frye (1976), p.204; Yarshater (1336 H.S.), p.25, n.1.

6. Dyakonov and Livshits (1960,b), p.82, ostracon 257; cf. p.15 of same work; cf. also Dyakonov and Livshits (1960,a) p.17, and ostracon 68 on p.25; Boyce (1970), p.516; Bickerman (1967), p.200; Frye (1976), p.204.

7. Vinnikov (1954), p.128, n.1.

8. Dyakonov and Livshits (1960,a) p.17; (1960, b), p.15, and ostracon 478 on p.85; cf. Frye (1976), p.204, in which the latest date is mistakenly written A.D.13.

9. Dyakonov and Livshits (1960, a), pp.17 ff.; (1953), pp.115,122; (1960,b), p.20 ff.; Vinnikov (1954), pp.122, 128; Yarshater (1336 H.S.), p.25, n.1; Bickerman (1966), p.15; Frye (1976), p.204.

but an independent attempt will be made here to prove the identity of the era and its epoch. The discussion will inevitably be limited by the small number of Nisa documents which have reached the publication stage (1).

Ostracon 1760 (2), dated 157 but without the month or month-day, is said to relate to the coronation of an Arsacid king, whose personal name is not mentioned, but whose genealogy is given as follows: "Arshak (Arsaces) King, grandson of Fraates, son of the nephew of Arshak (Arsaces)". The identification of the era by which this ostracon is dated is more feasible through identification of the only personal name given in this "puzzle", rather than from the genealogy itself. There are five members of the Arsacid dynasty whose personal names were Fraates and who became king (3). Of these five kings, the father of two of them, i.e. Fraates I and Fraates II, could actually be the nephew of the Arsaces who founded the dynasty. Dyakonov and Livshits identify the Fraates of the ostracon with Fraates II (128-123 B.C.)(4), whose father, Artabanus I (c. 211-191 B.C.), was, according to them, actually the nephew of the founder of the dynasty. One objection which can be made to this identification is the gap between the beginning of the reign of Artabanus (father) and the beginning of the reign of his son Fraates II, which is approximately 53 years. If Fraates II was born during the last year of his father's reign, he would have been 53 years of age when he became king, whereas he was in fact on the throne for about ten years, during which time he led his army into Mesopotamia and, after reoccupying that country, returned to the eastern frontier of Iran, where he was slain in a battle against the Sacae, while probably still relatively young (5).

The assumption that the Fraates of the ostracon is Fraates I (c. 176-171 B.C.) seems less probable. The interval between the last year of Fraates I's reign and the first year of the king in the ostracon, who claims to be the grandson of Fraates, will be at least 86 years. In this genealogy, as in many genealogical tables compiled

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1. At the time of writing, only a tenth of the documents have been published, in collections of 165 and 40 documents, by Dyakonov and Livshits (1960,a;1960,b) and a few examples in isolated articles by the Russian authors quoted in this section.

2. Dyakonov and Livshits (1960, a), pp.20-21; (1960, b), pp.20-21, 41, 113; see also Frye (1976), p.228, n.9; Bickerman (1966), pp.15-17.

3. Smith (1952), pp.43-44.

4. Dyakonov and Livshits (1960, a), p.20-21 (1960, b), pp.20-21; see also Frye (1976), p.228, n.9; cf. Bickerman (1966), p.16. For the precise duration of Fraates II's reign see Sellwood (1963), pp. 73-74.

5. Frye (1976), p.206.

by Iranian kings to prove their right to the succession, the omission of the father's name renders the claim doubtful; but it is nevertheless the best evidence for the historicity of the identity of the founder of the dynasty (1). The fact that this sort of genealogical table has no historical authority has long been known (2). Dyakonov and Livshits identify the king in the ostracon with Gotarzes I, whose coronation, according to them, took place in 157 A.E., corresponding to 91 B.C. (3). This is supported by the Babylonian documents, in which the name of the king Gotarzes is mentioned, rather than the Arsacid title (4). The earliest date in the Babylonian documents is 155 A.E., which is accompanied by thecorresponding Seleucid date 221 (5). As far as legibility allows, the latest date coupled with the name of Gotarzes is 161 A.E. (6), which indicates that Gotarzes claimed the throne round about this period; since his reign is therefore near to the date of the ostracon, it is reasonable to suppose that he is the king concerned.

Despite the different interpretations of the fragmentary sources, it is still possible to assert that the date on the ostracon is reckoned by the Seleucid era. In the above case, the year 157, if reckoned by the Seleucid era, should correspond, either by Babylonian or Macedonian reckoning, to the Julian date 156/155 B.C., i.e. a time at which Mithradates I was already on the throne (7). Mithradates I became king after Fraates I and ruled for nearly 33 years (8). Before the conquest of Babylon by Mithradates I (141 B.C.), the Arsacid kingdom was merely a province in the eastern part of Iran (Parthia), whereas we know that in the presence of Mithradates I, no one could call

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1. See above, p.67.

2. See Bīrūnī (1879), pp.44-45; (1352 H.S.), pp.61-62; cf. Dyakonov et al. (1953), p.129; Bickerman (1966), pp.15-16.

3. Dyakonov and Livshits (1960, a), pp.20-21; Dyakonov et al. (1953), p.127, n.1, which gives the genealogical table of the first kings of the Arsacid dynasty.

4. Gotarzes and his immediate successor Orodes are the only Parthian kings in all the documents mentioned by their personal names, rather than using the dynastic title; see Minns (1915), pp.34-35; Debevoise (1938), pp.48-49, n.77; Sellwood (1962), pp.73-74; Simonetta (1966), pp.18-19.

5. Minns (1915), p.34; Simonetta (1966), p.19.

6. Minns (1915), p.34; Simonetta (1966), p.19.

7. See Frye (1976), p.299; Pīrnīyā (1344 H.S.), pp.2087, 2231; Sellwood (1962), pp.74-76.

8. Frye (1976), pp.205-206, 299; Parker and Dubberstein (1946), p.22; Pīrnīyā (1344 H.S.), p.2220.

himself King (1). Mithradates I conquered Babylon; after entrusting the conduct of further military affairs in western Iran to his deputy, he arrived back in eastern Iran in about 155 B.C. (2). There is nothing to suggest, either on coinage, in literary sources, or in the Babylonian documents, that Gotarzes or anybody else set himself up as an independent ruler in Babylon or Nisa, or in any of the Greek colonies in eastern Iran which had passed to the Arsacids during the reign of Mithradates I (3) or earlier (4). Consequently, the king of the ostracon cannot be other than Gotarzes I, and the era used on the Nisa documents cannot be other than the Arsacid era.

The Nisa documents so far published do not include a double-dated document or a document making mention of astronomical phenomena, such as an eclipse of the sun or moon. In cases where the dates are not linked to historical events, it is almost impossible to verify the epoch of the era, or the first day of any calendar year in relation to the astronomical seasonal points. In the Zoroastrian calendar, in which the length of the year was calculated as exactly 365 days (assuming that the 120-year intercalation was not implemented during the Arsacid period), the beginning of the year, and also the beginning of every month, was displaced by one day in every four years, or one month in every 124 years, in relation to the astronomical seasonal points (see Chapter III). Consequently, even if it were possible to establish the epoch of the Arsacid era or the starting point of the first Zoroastrian year in which the Arsacid era is located by reckoning according to the Zoroastrian calendar, even so the available information, which includes no record of the insertion of an intercalary month every 120 years in accordance with Zoroastrian time-reckoning practice, would be insufficient to determine the relative positions of the months mentioned on the Nisa documents.

If the few Nisa documents dated by the month and month-day belonged to the group of ostraca dealing with the delivery of the vintage, which is unfortunately not the case (5), it would be possible to find the approximate location of the month in relation to the astronomical

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1. See Pīrnīyā (1344 H.S.), pp.2220 ff.

2. Masson (1963), p.154; Frye (1976), p.205.

3. In a few of the published documents, the name of the province from which the wine was collected is Godarzgan, deriving its name, like many of the other provinces mentioned, from that of an Arsacid king. It is possible that the Gotarzes of the ostracon was governor of the province, which received this name before he became king in 90 B.C. See Dyakonov and Livshits (1960, b), pp.77, 79, 110: ostracon 100, dated 174 A.E.; ostracon 112, dated 175 A.E.; ostracon 1651, dated 176 A.E.; cf. Bickerman (1966), p.16.

4. Frye (1976), pp.205-206.

5. Livshits and Lukonin (1960), p.160; Dyakonov and Livshits (1960, a), p.16.

season in which the grapes were harvested (1).

The documents dated by the month and month-day usually begin with the date (2). In none of the small number of documents relating to the delivery of grapes is the month or month-day mentioned. Bearing in mind the primitive method of wine-making, where the grapes were merely placed in a vessel and left to ferment, this group of documents will be annual records of wine-making and wine-weights, written sometime later, when the wine or vinegar was measured after the vessel had been opened (3).

Ostracon No. 2119 (4) is dated by the month and month-day, without the year: "month Shahrīvar"(the name of the sixth month of the year and also of the fourth day of the month in the modern Zoroastrian calendar; see Tables 1 and 5); "day Khurdād" (seventh day of the month). One other document in this group is dated "year 176, month Farvardīn" (first month),"day Surūsh" (17th day of month)(5).

Now let us consider the date on Avroman parchment III, which in all probability is also dated by the Arsacid era and the Zoroastrian method of time-reckoning (see p.59). The location of the discovery of this document led certain scholars to conclude that the Zoroastrian month-names were used in Kurdistān (6). The fact that the continual westward migration of the Arsacids from their homeland or early centre in the north-east of Iran (7), together with the considerable development of commerce and trade during this period (8), had attracted many of the inhabitants of the north-east of Iran to western parts as far as Dura Europos, has been overlooked by these scholars. There is no similarity between Avroman parchment III and other documents found in the western part of the Arsacid kingdom. The difference between parchment III and parchments I and II, which were discovered at the same site (9), is not only one of language and characters: the method of

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1. Precise dates for the various agricultural operations, and particularly for the vintage for this part of Iran can be found in many works of the early post-Islamic period. See Bīrūnī (1879), p.230; (1352 H.S.), p.320.

2. Vinnikov (1954), p.121; Dyakonov and Livshits (1960, a), p.37.

3. See Dyakonov and Livshits (1960,b), pp.15-17.

4. Dyakonov and Livshits (1960, a), p.37; see ostracon 2167 on same p.

5. Livshits and Lukonin (1960), pp.158, n.22, 160, n.23. Of the three ostraca published by these co-authors, one is dated by a Khwārazmian month-name.

6. Tarn (1932), p.592.

7. Frumkin (1970), p.142; see also Ghirshman (1349 H.S.), pp. 288, 342; Frye (1976), p.205.

8. Ghirshman (1349 H.S.), pp.294, 338; see also Debevoise (1938), pp.203 ff.

9. Minns (1915), pp.22-23.

dating, the method of time-reckoning, and the era by which the years are calculated are completely different. Whereas the date on Avroman parchments I and II, like that on Dura Europos Nos. 18, 19 and 20 (see above, p.70), is given by a long formula: "In the reign of the King of Kings Arsaces, the benefactor, the just, the Manifest, and Philhellene"(1), followed by the date with Macedonian month-names, the date on Avroman parchment III, like Nisa ostraca Nos. 2167 and 2119, is given after the word "year" in alphabetical digits (2). The month-name, as on Nisa ostracon No. 2119, is Zoroastrian in form. There can be no doubt that the era by which the date is given in Avroman parchment III is none other than the Arsacid era, combined with the Zoroastrian method of time-reckoning (see sections III.I, III.II). It is reasonable to suppose, therefore, that Avroman parchment III is not the work of the inhabitants of the site at which it was discovered (Avroman in Kurdistān); it is quite possible that the parties involved in the contract for the sale of a vineyard (Avroman parchment III) were from north-east Iran, having emigrated to this region.

There is another possibility: either the characters representing the date on Avroman parchment III represent the number 321 (in accordance with Sayce's reading)(3), or they are equivalent to 300 (after Cawley)(4), reckoning by the Arsacid era; the corresponding Julian dates, following the two theories, are A.D. 53 and A.D.74 (5), both dates falling within the reign of Vologeses I (c. A.D.51-80). If the collection of Avestan fragments attributed in the Dinkard to Valakhsh (6) can be attributed to Vologeses I (7), which is probable in view of the similarity of the names, it is reasonable to accept that, during the reign of this king, who was a "good" Zoroastrian, the Zoroastrian calendar, which had originated in north-east Iran (8), spread to western Iran under his patronage.

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1. Minns (1915), pp.31-32.

2. Vinnikov (1954), p.121; see also Livshits and Lukonin (1960), p.182, n.22; Yarshater (1336 H.S.), p.25.

3. Sayce (1919), p.203.

4. Cowley (1919), p.152.

5. Debevoise (1938), p.202, n.62; Bickerman (1967), p.204; see also Yarshater (1336 H.S.), p.24, n.2; Taqīzādeh (1938), p.4, n.2; (1346 H.S.), p.55, n.2.

6. See West (1892), p.413.

7. See Darmesteter (1880), pp.xxxiv-xxxv; West (1892), p.413, n.5; (1880), pp.199-200, n.7; (1897), p.xlvi; Williams Jackson (1925), p.40; Pīrnīyā (1344 H.S.), p.2691; Humā'ī (1340 H.S.), p.142; Unvala (1914), p.9; Rypka (1968), p.16; Boyce (1975), p.20.

8. Bickerman (1967), p.205.

Not only is there a complete lack of contemporary literary relics of the Arsacids; there are also no allusions to the use of the Arsacid era in literary sources from later centuries. All the above is based on dated documents which lay buried for more than 2000 years. For nearly 500 years, the Arsacids ruled an area at times in excess of 3,000,000 square kilometres. They showed such tolerance with regard to the religions of their subjects (1) that many Jewish and Christian immigrants from the Roman Empire were attracted to Iran (2). The Arsacids entrusted provincial administration to as many as 18 local "kinglets", known as Mulūk al-Ṭawā'if (3). During this long period and over this vast area, many other systems of time-reckoning must have been used, but their existence will only be proved by further archaeological discoveries.

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1. Ghirshman (1349 H.S.), p.323.

2. Rawlinson (1872), p.401; see also Unvala (1914), p.4.

3. See Frye (1976), p.211.

4. Ṭabarī (1352-1354 H.S.), pp.496-500, 580, 585-586; Ḥamza (1932), pp.27-29; (1346 H.S.), pp.17, 41; Mas'udī (1344 H.S.), pp. 228 ff.

CHAPTER III

The Zoroastrian calendars

III.I. The early Zoroastrian calendar

The method of time-reckoning variously referred to as Zoroastrian, Mazdayasnian, Fārsī (Pārsī), Fārsīya, Persian, Iranian, Magian or Yazdgirdī (see Section III.II , IV.I , IV.II) is related to earlier Iranian methods of time-reckoning. While a great deal of reliable information is available about the use of this method during the Islamic period up to the present day (it is still in common use among Zoroastrian communities in Iran and India)(see Sections IV.I , IV, II); there are neither contemporary reports nor sufficient trustworthy later information about its details during the Parthian and Sasanian periods (1). Apart from dates given by the Zoroastrian month-names and month-days (2), information concerning the Zoroastrian method of time-reckoning is basically limited to Bīrūnī's works and to Pahlavi writings, neither of which are irreproachable in this connection. Other sources and sources written in later centuries do not add to our knowledge and are no less unreliable.

In several passages on the Zoroastrian calendar prior to Islamic domination, Bīrūnī, whose al-Āthār al-Bāqīya (The Chronology of Ancient Nations) is the standard work on early Iranian chronology up to the middle of the 11th century A.D., points to much uncertainty and confusion in Persian chronology (3). Bearing this in mind, it is not entirely unexpected to find that his information on the subject, covering a period going back 900 years before his own time, is neither consistent nor acceptable except in cases where it can be corroborated scientifically or by calendar-facts.

Among Pahlavi writings, the Bundahishn is the major source dealing directly with Iranian chronology. Its reliability is much more questionable than that of Bīrūnī. The author exhibits such an imperfect knowledge of elementary principles of calendar-structure that doubt is even cast on the accuracy of his technical expressions. He

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1. Cf. Taqīzādeh ([1938], p.2; [1346 H.S.], p.52): "All our information regarding the pre-Islamic calendar is derived from works composed later than the eighth century A.D. Nevertheless, we have no reason to doubt the statements of the learned Persians of post-Sasanian times as to the calendar of their not very remote ancestors." It is no surprise to find that most calendars, being derived to some extent from such sources and partly from old and new "conjectures" (see Taqīzādeh [1938], pp.12-17), are not confirmed either by the above-mentioned sources, or by contemporary documents now to hand; see Bickerman [1967], p.202, n.19.

2. See Section II.IV. and Ṭabarī [1352-1354 H.S.], pp.767, 774, 779, 881, 882; Ḥamza [1346 H.S.], pp.179, 181, 215-217.

3. Bīrūnī [1879], pp.38, 122, 185; cf. [1352 H.S.], pp.54, 164, 261 (note mistranslation!).

gives the length of the lunar year as 354 days and 4 hours (1), which is 4 hours, 48 minutes, 37 seconds shorter than its actual length, which had long been known (see Section I.IV). As Taqīzādeh clearly shows, the author of the Bundahishn did not even realize that the vernal equinox applied to one day only (2).

It is now clear that the various investigations made during the past three centuries on the date of the introduction of the Zoroastrian method of time-reckoning have reached incorrect conclusions. Since most of the "first-hand" sources dealing with the Zoroastrian calendar are readily accessible (although they are not in fact contemporary with the Sasanians, they go back more than one thousand years), it is not necessary, and sometimes unwise, to depend on modern studies in this field. Examination of the rather obscure information given in these "first-hand" sources underlines the weakness of the conjectural suppositions made in recent works (3).

The length of the year in the Zoroastrian calendar in all these sources is 365 days, divided into twelve months, each of thirty days, plus five supplementary (epagomenal) days. The names and order of the months listed in Table 5 can be encountered in numerous sources, sufficient to leave no doubts as to their order, despite the doubts expressed by certain modern scholars. Since a year of 365 days is shorter by 5 hours, 48 minutes and 46.8 seconds than the true length of the natural, so-called seasonal or tropical year (see Section I.IV), this discrepancy constitutes roughly one day in every four years. The difference runs to nearly one month in 124 years:

$$365 \times 124 = 45{,}260$$

$$365.2422 \times 124 = 45{,}290.0328$$

$$45{,}290.0328 - 45{,}260 = 30.0328$$

Consequently, the beginning of the year, and the months themselves, move through a complete tropical year in 1508 years (4):

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1. Bundahishn (1880), Ch.25, v.18, pp.96-97; (1956), Ch.25, v.22, p.209.

2. Taqīzādeh (1938), p.11; (1346 H.S.), p.62.

3. See Ginzel (1906), pp.294-295; Ideler (1826), pp.543-544; Taqīzādeh (1938), pp.5-11; (1346 H.S.), pp.55-62; Bickerman (1967), pp.199-203; Boyce (1970), pp.514-523.

4. The cycle of 1508 years is derived from the correct duration of the tropical year, which is approximately 365.242199 days, whereas most present-day historians dealing with the Zoroastrian calendar, influenced by sources composed at a time when the true length of the tropical year was by no means common knowledge, still rely on the Egyptian sothic cycle of 1460 or 1461 years, which would be correct if the length of the tropical year were 365.25 days. For earlier sources, see Kūshyār, apud Ideler (1826), pp.546, 624; Bīrūnī (1879), p.12; (1352 H.S.), p.18; Mullā Muẓaffar (1267 A.H.), Bāb 3rd. For present-day authors, see Paruck (1937), pp.61-62, where he gives the incorrect cycle of 1440 years, which is later repeated by Taqīzādeh (1346 H.S.), p.418; cf. Taqīzādeh (1317 H.S.), pp.22, n.51, 39, 117, n.249.

$$365.2422 \div 0.2422 = 1508$$

This method of time-reckoning is neither solar nor lunar, and the beginning of a year cannot be fixed at any one of the astronomical seasonal points (see Section I.IV). The 30-day months do not have any connection either with the astronomical seasons and the period in which the sun remains in one of the signs of the zodiac, or with the course of lunation (see Section I.II). Bīrūnī records the tradition that it was Zoroaster who intercalated months on the basis of the accumulated quarter-days, to bring the calendar-years back to their original relative position (1). Bīrūnī also states that Zoroaster then commanded the people at all future times to treat the quarter-days in the same way, and that they obeyed his command. While most authors of the eighth century A.D. onwards, when dealing with the Zoroastrian calendar, maintain that the Iranians totalled the fractions of the years in the course of 120 years, then intercalated one complete month of 30 days after the last month of the 120th year to bring the beginning of the year to its original location (2), a few authors give the period of intercalation as 116 years. The author of "Tārīkh-i Qum" states that "the length of the true year is 365¼ days and a bit, but the Iranians reckoned only the quarters and inserted one month in 116 years"(3). The period in which the quarter-days add up to one complete month of 30 days should in fact be 120 years, i.e. [(120 x ¼) ÷ 24 = 30]. Bīrūnī, who discusses the pre-Islamic Zoroastrian calendar in several passages in "al-Athār al-Bāqīya"(4), "al-Tafhīm"(5) and "Qānūn-i Mas'ūdī"(6), gives the intercalation period in one passage of "al-Āthār al-Bāqīya" as 116 years (7), which not only contradicts other passages in the same book and his other works,

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1. Bīrūnī (1879), p.55; (1352 H.S.), p.72.

2. Kūshyār and Qutb-al-Dīn, apud Ideler (1826), pp.541-542, 547-548, 624-625; for Khwārazmī, see Ibn al-Muthannā (1967), pp.19-20; Nawrūz-nāma (1312 H.S.), p.11; Mullā Muẓaffar (1267 A.H.); Dinkard (1900), p.15; see also Ginzel (1906), pp.290-291; Humā'ī (1340 H.S.), pp.365-366; Taqīzādeh (1317 H.S.), pp.19-20, n.40; (1938), pp.5-7; (1346 H.S.), p.58; Bickerman (1967), p.199, n.9; cf. Boyce (1970), pp.528-529. There are many other sources, both old and new, relating to this question, which are too numerous to quote.

3. Tārīkh-i Qum (1313 H.S.), p.146.

4. Bīrūnī (1879), pp.12-13, 36-39, 52-56, 121, 184-185, 220-221; (1352 H.S.), pp.18, 51-54, 68-72, 260-262, 208-209.

5. Bīrūnī (1934), p.163; (1316-1318 H.S.), p.222.

6. Bīrūnī (1373 A.H.,I), pp.131-133.

7. Bīrūnī (1879), pp.12-13; (1352 H.S.), p.18.

but also assumes a different year-length from that given in "Tārīkh-i Qum". In this work only, Bīrūnī defines the cycle as 116 years on the basis of the length of the Zoroastrian year imparted to him by an anonymous informant, i.e. 365 days, 6 hours and 12 minutes, despite the fact that he was aware that the length of the true seasonal year, which according to his own observations was 365 days, 5 hours, 46 minutes, 20 seconds and 56/60 of a second (1), was shorter than this adopted duration of the Zoroastrian year. He appreciated that the intercalation had to be in the form of an intercalary month of 30 days; he accordingly arrived at a cycle of 116 years, which was correct in relation to the given length of the year. In the same context, he makes the strange statement that the Iranians reckoned their year as 365 days, disregarding the fractions until the quarter-days had accumulated in the course of 120 years to the number of days of one complete month , and until the 12 minutes, which they believed followed the 6 hours, had accumulated to one day; they then added the complete month to the year in each 116th year. Elsewhere in "al-Āthār al-Bāqīya" and other works, Bīrūnī is in agreement with other astronomers and historians in giving the Zoroastrian period of intercalation as 120 years. In some places he gives the year-length of the pre-Islamic Zoroastrian calendar as $365\frac{1}{4}$ days (2). In other places, however, quoting "people's assertions", he gives it as 365 days, 6 hours and 1 minute; he writes that the ancient Iranians reckoned the one minute as a part of the quarter of a day (i.e. they disregarded the one minute in their computations)(3). The author of the Bundahishn gives the same year-length for Zoroastrian time-reckoning (4), but also gives another, different length, which will be discussed later. Regardless of whether the Iranians calculated the length of the year as $365\frac{1}{4}$ days or 365 days, 6 hours and 12 minutes (5), these lengths render concordance between the year and the seasons impossible because these durations are longer than the true length of the year, and the year cannot therefore be restored to its original relationship with the seasons by any form of intercalation.

Certain authors claim that the Iranians based their calendar on the length of the sidereal year (6). There is, however, no evidence to support this supposition, and the duration adopted by the Iranians for their calendar-year is not equal to the length of the sidereal year; even if it were, their calendar-year could not be fixed in relation to the astronomical seasons (see Section I.IV). In view of most of Bīrūnī's statements, together with those of other astronomers and historians, there can be little doubt that the Zoroastrian Iranians used 120 years for their intercalation cycle.

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1. Bīrūnī (1879), p.141; (1352 H.S.), p.190.

2. Bīrūnī (1879), pp.37, 53, 54; (1352 H.S.), pp.70-71.

3. Bīrūnī (1879), p.222; (1352 H.S.), p.308.

4. Bundahishn (1880), Ch.25, v.21, p.97; cf. Bundahishn (1956), Ch.25, v.26, p.211.

5. See Taqīzādeh (1938), pp.53-54; (1346 H.S.), pp.112-113.

6. Kuka (1900), pp.54-55; Mehta (1940), p.15.

Some sources state that the Zoroastrians did not give the intercalary month a special name, neither did they repeat the name of the month preceding or following the intercalary month (1). Bīrūnī, who agrees on this point, states elsewhere that the thirteenth month was called the intercalary month (Kabīsa)(2). Since the word Kabīsa is originally Arabic, signifying "intercalation", this must have been the name given to this month after the Islamic conquest. In "al-Tafhīm", Bīrūnī states that the name of one month was repeated for the intercalary month (3). Bīrūnī also asserts that "Fīrūz b. Yazdgird" (Pīrūz; c. A.D.459-484) intercalated two months at the same time (see below), but he gives no name for the intercalary months. With such a variety of reports, the question is impossible to resolve definitively.

The Iranians used the same name for the days of the intercalary month as they did for ordinary months (4). According to Bīrūnī, in order to avoid confusion as to the location of the intercalation, they moved the five supplementary days, which were originally placed before New Year's Day (5), one month later in every successive intercalary cycle (6).

To give a more precise explanation of the method of Zoroastrian intercalation, let us suppose that at the time of its introduction the beginning of the calendar year (Nawrūz) was located at the vernal equinox. Because of the discrepancy between the length of the Zoroastrian calendar-year and the true length of the solar year, the Zoroastrians believed that Nawrūz would move one month earlier in relation to the advent of spring every 120 years. In order to restore Nawrūz to its original location, they intercalated a thirteenth month after the last month of the 120th year; the five supplementary days were moved from the end of the twelfth month to the end of the intercalary month of the same year. The intercalary month was actually the first month of the next year, but it was counted as the thirteenth of the

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1. Bīrūnī (1879), p.55; see also Paruck (1937), p.59; Bickerman (1967), p.199.

2. Bīrūnī (1879), p.55; cf. Ideler (1826) , p.549, in which he states that "the 13th month was called 'Bihtarak' the better one". Ideler's assertion is quoted by Ginzel ((1906), p.294), but is based on a misunderstanding of Bīrūnī's record.

3. Bīrūnī (1934), p.163; (1316-1318 H.S.), p.222; see also Quṭb al-Dīn, apud Ideler (1826), p.541; Ginzel (1906), pp.290-291; Mullā Muẓaffar (1267 A.H.), Bāb 2nd; Mīnovī (1335 H.S.), p.86.

4. Bīrūnī (1879), pp.54-55; cf. Dānāsirisht (1352 H.S.), p.71, in which a mistranslation entirely changes the meaning of Bīrūnī's statement. See also Mas'ūdī (1344 H.S.), p.555; Mullā Muẓaffar (1267 A.H.), Bab. 2nd.

5. See Bīrūnī (1879), p.55; (1352 H.S.), p.72; (1934), p.180; (1316-1318 H.S.), p.253; Kūshyār, apud Ideler (1826), pp.547, 625; Ginzel (1906), p.291; West (1880), p.24, n.1; Dinkard (1900), p.16.

6. Bīrūnī (1879), p.55; (1352 H.S.), p.72; (1934), p.166;(1316-1318), p.230.

previous year, and then, in the second 120-year cycle, the five supplementary days were placed at the end of the first month. In the last year of the second 120-year cycle, which was the due date of the second intercalation, the intercalary month was inserted between the first month and the five supplementary days. The five supplementary days in the third cycle were, therefore, placed at the end of the second month, where they remained until the next intercalation, and so on. In this way, the location of the five supplementary days, at the end of the month after which the next intercalary month would be inserted, indicates the number of cycles which had elapsed. The resultant order of the Zoroastrian months in the first eight cycles is shown in Table 5.

Whether or not the actual practice was such, this description of the Zoroastrian method of intercalation agrees with the explanation given in several earlier sources and is one of the few questions on which there appeared to be general agreement (1). Nevertheless, recent authors have arrived at a variety of different interpretations. West, for example, states that "...an extra month to be intercalated, between the last month of the year and the five extra days, by merely moving those five days from the end of the twelfth month to the end of the first month of the next year"(2). On this basis, the 120th year of the second cycle would no longer include five supplementary days, otherwise the intercalation would have had to be a month of 25 days, not 30 days. After discussing the certain fact that the Zoroastrian month of intercalation lasted 30 days and that the five supplementary days were not omitted in the intercalary year (3), West concludes that the change in position of the five supplementary days was accompanied by the shifting of New Year's Day from its original location (4), i.e. at the beginning of the first month of the Zoroastrian calendar, to the first day of the second month (see p.105). In this connection he writes, "All following years would begin with the second month 'Urdībihisht', and end with the first month 'Farvardīn' and the five supplementary days until the second intercalation"(5). The main objection to this supposition is that the reason for the intercalation, as West himself remarks, was to restore New Year's Day to its original location (6), whereas with the supposed transfer of New Year's Day to

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1. Bīrūnī (1879), pp.38, 53-56, 185, 221; (1352 H.S.), pp.76, 261, 309; see also Kūshyār, apud Ideler (1826), pp.547, 624; Ginzel (1906), pp.290-291; Bīrjandī (Ethe 2237), Folios 17^a-18^a; Mullā Muẓaffar (1267 A.H.), Bāb 2nd.; Qūshchī (1304 A.H.), Bab. 9th.

2. West (1897), p.xlv; see also Ideler (1826), pp.241, 248-249; Ginzel (1906), pp.294-295.

3. West (1897), p.xlv.

4. Ibid.

5. Ibid.

6. Ibid.

the beginning of the next month of the series, not only was the beginning of the year not returned to its original location, but it was advanced by one month in every 120-year cycle. Certain scholars, however, accepting that the change of the position of the five supplementary days did not displace New Year's Day, assert that the intercalation took place at the end of the twelfth month of the last year of the second 120-year cycle, and the five supplementary days were moved to the end of the first month of the following year. Other authors give tacit approval to this view (1). If this view is in fact correct, in the last year of the second and subsequent cycles, either the five supplementary days must have been omitted or the intercalary month must have been shortened to 25 days; the length of the year in each cycle would be 365 days, 4 hours, 59 minutes, 59 seconds:

(120 x 365) + 25 = 43,825

43,825 ÷ 120 = 360.2083333

0.2083333 = 4 hours, 59 minutes, 59 seconds

None of the sources, however, contains evidence in favour of any such hypotheses. It is, of course, not beyond the realm of possibility that the ancient Iranians, who invented this method of intercalation and whose astronomical knowledge was inferior to that of modern scholars, unwittingly made this mistake; but early sources do not support this view.

Another problem concerning the location of the five supplementary days is that one of the several names for these days is "andar-gāh"(2) (andar = "in between"; gāh = "period of time"). Gāh is applied not only to each of the five parts of the nychthemeron (see Section I.I), but also to each of the six parts of the year (see Section III.II, p.113), as divided by the Iranians. Bearing in mind that, according to the

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1. See Taqīzādeh (1317 H.S.), pp.24, n.56, 117, n.249, 131, n.277. Taqīzādeh, in the above footnotes, explicitly states that the five supplementary days were omitted in the last year of the first intercalary cycle, whereas in a footnote to pages 80-81 he expresses the opinion that the five supplementary days of the last year of the first cycle must have remained in their original location. In a later article ((1952), p.608; (1346 H.S.), p.402) he states that "When the Gāhanbārs were for the first time moved forward at the first intercalation (presumably in 321 B.C. or thereabouts), the epagomenae proceed 30 days to the end of the first month". This statement undoubtedly means that the epagomenae of the last year of the first intercalation cycle were omitted, whereas his statement on the same page "the Vahījakīk year was kept fixed by instituting a kind of intercalation by which once in each 120 years the Gāhanbārs were moved 30 days forwards. They kept the new positions for the next 120 years" implies that the epagomenae were not omitted.

2. See Bīrūnī (1879), p.53; (1352 H.S.), p.69; Humā'ī (1316-1318 H.S.), intro. pp.133, 175 (i.e. "فلیح", "فوه"); Boyce (1970), p.518.

Zoroastrian method of intercalation, the location of the five supplementary days was not always the same in relation to the months and to the six parts of the year (gāhanbār), it is now impossible to determine with any degree of certainty where the five supplementary days stood in the main branch of Zoroastrian calendar during the first eight cycles (see below).

Bīrūnī records that the intercalation was entrusted to a group of mathematicians, literary notables, historiographers and chroniclers, priests and judges, who met to reach agreement on the date of the intercalation on the basis of their computation of the true length of the year. Determination of the year in which the intercalary month was to be inserted was a matter of great importance to the king and his subjects for both taxation and religious reasons; the king sometimes postponed the intercalation when the empire was disturbed by calamities (1). According to the Dinkard (probably written in the ninth century A.D.), the maximum permissible postponement was 600 years, during which the year-fractions (~ 6 hours) would accumulate to five months (2). According to Bīrūnī, the last intercalation to be made in the Zoroastrian calendar (in the last year of the seventh cycle) was of two months simultaneously, one at its appointed time, the other "in anticipation" of a possible oversight 120 years hence, or as an insurance against future calamities (3). This double intercalation is said by Bīrūnī to have taken place "nearly - but not exactly" 190 years before the death of "Yazdgird b. Shahrīyār"(4), sometimes referred to as Yazdgird III (A.D.632-651). However, Bīrūnī gives the name of the Sasanian king under whose patronage this double intercalation took place as "Yazdgird b. Shāpūr" (= Yazdgird I, c. A.D.399-421)(5). It is the present writer's view that the king concerned was Pīrūz (A.D.459-484), whose name is given by Bīrūnī in this connection in his work "Qānūn-i Mas'ūdī"(6), (see below). Modern scholars are at variance in their identification of the king, some even mistakenly attributing the operation to Yazdgird I

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1. Bīrūnī (1879), pp.54-55; (1352 H.S.), pp.70-72; see also Paruck (1937), p.67; Mīnovī (1312 H.S.), p.86; Boyce (1970), p.528.

2. Dinkard (1900), pp.15, 26.

3. Bīrūnī (1879), p.56; (1352 H.S.), p.72; see also Ginzel (1906), pp.291-292; Taqīzādeh (1938), pp.36-37, 50-54; (1352 H.S.), pp.90-91, 109-112; cf. Bihrūz (1331 H.S.), pp.81-82, where Bihrūz claims that the Manichaeans had for religious reasons "tampered with" the text of Bīrūnī's al-Āthār al-Bāqīya; elsewhere (Bihrūz (1347 H.S.), p.31, n.2), without mentioning his source of information, he asserts that two intercalations were performed during the reign of Yazdgird I.

4. Bīrūnī (1879), p.38; (1352 H.S.), p.54.

5. Bīrūnī (1879), pp.38, 56, 121; (1352 H.S.), pp.54, 72, 162.

6. Bīrūnī (1373 A.H.,I), p.142.

(A.D.399-421)(1), Kavad (Qubādh) (A.D.488-531)(2), Khusraw I (A.D.531-579) and Yazdgird III (3). An examination of this question in depth would involve too long a digression, but since the problem represents both a corner-stone and mile-stone of studies in this field, it deserves at least brief consideration. The attribution of the last and double intercalation to Yazdgird b. Shāpūr (Yazdgird I) by Bīrūnī in his book "al-Āthār al-Bāqiya", and also the attribution of the same to Pīrūz by the same author in his book "Qānūn-i Mas'ūdī" has frequently been misinterpreted by modern authors as a contradiction in Bīrūnī's accounts. Taqīzādeh, who has dealt with this question in several articles, books and lectures, considers the attribution to Pīrūz to be incorrect (4) and prefers to base his extensive studies on the name given by Bīrūnī in "al-Āthār al-Bāqiya", i.e. Yazdgird b. Shāpūr. However, the date given by Bīrūnī in the same book, and on the same page (5), presents complications, being the date of a regnal year which involves the problem of the cycle of intercalation. Computation of this date indicates that the king responsible for the double intercalation must have been Pīrūz, the same king as in "Qanūn-i Mas'ūdī". Bīrūnī gives the interval between the last year of the reign of the king by whose order the last and double intercalation had been carried out and the death of Yazdgird b. Shahrīyār (A.D.631-651) as "nearly, but not exactly" 190 years. The implication is that the 190-year period consists of two subdivisions: a cycle of 120 years, whose one intercalary month had already been inserted and whose five supplementary days were placed after Ābān Māh (the eighth month of the year); and 70 years, representing the period from the last year of this cycle until the death of Yazdgird III (Yazdgird b. Shahrīyār). According to Bīrūnī, the beginning of the Iranian year had been displaced by 17 days at the time of the death of Yazdgird III ((70 x 365.2422) - (70 x 365) = 16.954)(6). Consequently, the name of the king and the period

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1. Paruck (1937), pp.66-67; Taqīzādeh (1938), pp.36-37, 51; (1346 H.S.), pp.90-91, 110, 403, 406-408; (1349 H.S.), pp.200-201; Mehta (1940), p.23; Bulsara (1953), p.187.

2. Boyce (1970), p.528, where the record given by Bīrūnī is interpreted as the postponement of Nawrūz by eight full months by Yazdgird I or Pīrūz. According to the same author, there is a Sasanian "melody-name" which suggests rather that this took place during the reign of Kavād (Qubādh; A.D.488-531).

3. Unvala (1900), p.246; Gutschmid, apud Ginzel (1906), p.296, apud Taqīzādeh (1938), p.5. The dispute over the attribution of the simultaneous two-month intercalation to Anūshirwān or Yazdgird III is discussed by Taqīzādeh: there is no need for further explanation; see Taqīzādeh (1317 H.S.), pp.221-222, n.370; also Bickerman (1967), pp.200, 203, where the author has gathered together records of simultaneous two-month intercalations, concluding with the statement that he is unprepared to choose between the possible kings.

4. Taqīzādeh (1338), p.37; (1346 H.S.), pp.91 ff.; cf. (1317 H.S.), pp.23-24.

5. Bīrūnī (1879), p.38; (1352 H.S.), p.54.

6. Ibid.

in which the two intercalary months had been inserted, can be obtained by subtracting these 190 years from the date of the death of Yazdgird III, i.e. A.D.651 - 190 = 461, at which time Pīrūz was on the throne. One could object to this conclusion on the grounds that, while Bīrūnī himself gives five different tables for the chronology of the Sasanian dynasty in the same book, the result obtained above is based on the dates given for the reigns of the Sasanian kings in modern works. However, the same result can be arrived at by using the five tables which Bīrūnī himself derived from different sources. Let us, therefore, apply this approach to the problem we have just been considering.

The last year of the reign of Yazdgird III (Yazdgird b. Shahrīyār) is given in Bīrūnī's tables (in order of appearance in "al-Āthār al-Bāqiya", the tables not all being numbered) as the 431st (1), 479th (2), 454th (3), 443rd (4) and 696th year (5) from the foundation of the Sasanian kingdom by Ardashīr b. Bābak (c. A.D.226-240). The period of Pīrūz' reign is also given (in the same table-order) as 235-262, 283-310, 269-286, 248-275 and 463-492 years from the foundation of the dynasty. Subtracting the 190 years from the five different dates given for the last year of Yazdgird III's reign gives: 241, 289, 264, 253 and 506. The first, second and fourth of these dates all fall within the reign of Pīrūz, according to the respective table. The third date (264) is five years before the beginning of his reign (in the table concerned). Since the duration of Pīrūz' reign is given in this table (table III, p.125) as 17 years, which is nearly 10 years shorter than that given in Bīrūnī's four other tables (which give the correct duration)(6), the date 264 must also, on this basis, fall within the reign of this king. The fifth date (506) derived from the table on page 128 of "al-Āthār al-Bāqiya", confirms Bīrūnī's own expressed doubts about that particular table's accuracy (7), in view of the implied duration of the Sasanian dynasty (506 + 190 = 696). Nevertheless, even this table of questionable accuracy gives a date of double intercalation which is only 14 years out in relation to the period of Pīrūz' reign.

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1. Bīrūnī (1879), p.123; (1352 H.S.), pp.165-167.

2. Bīrūnī (1879), p.124; (1352 H.S.), pp.167-168.

3. Bīrūnī (1879), p.125; (1352 H.S.), pp.169-170.

4. Bīrūnī (1879), p.126; (1352 H.S.), pp.170-171.

5. Bīrūnī (1879), p.128; (1352 H.S.), pp.173-174.

6. See Ṭabarī (1352-1354 H.S.), p.629; Ḥamza (1932), p.17; (1346 H.S.), pp.11, 16 ff., 24; Ya'qūbī (1347 H.S.), p.201; Ibn Athīr (1349 H.S.), p.80; cf. Ghirshman (1349 H.S.), p.359; Frye (1976), p.300.

7. Bīrūnī (1879), pp.122, 127; (1352 H.S.), pp.164, 172-173; according to Bīrūnī, he obtained this table from Ḥamza, who himself expressed doubts about the accuracy of the table (see Ḥamza (1346 H.S.), pp.17-18). Some of the figures given by Bīrūnī differ from those of Ḥamza.

However, if the king, during whose reign the last and double intercalation was carried out, is taken to be Yazdgird b. Shāpūr (Yazdgird I), as many scholars believe, the third and fifth dates quoted above (264 and 506) are 23 and 233 years later than the last year of Yazdgird I's reign, respectively.

Bearing in mind that, according to Bīrūnī, the date of intercalation was based on computation of the true length of the year by a council of mathematicians, and regardless of whether the true length of the year was based on contemporary astronomical observations or calculated from the average displacement of New Year's Day in relation to the astronomical seasonal points during the preceding 120-year cycle, we have good grounds to assume that the date of the intercalation was considered by astronomers of later times to be the date of an official astronomical observation. Taqīzādeh, who believes that the double intercalation was carried-out during the reign of Yazdgird I, does not challenge the date given by the astronomer Ibn Yūnus (died A.D.1009) in his book "al-Zīj al-Kabīr al-Ḥākimī" for the first observation by the Iranians in the reign of Pīrūz (1).

In addition to Bīrūnī's accounts relating to the simultaneous two-month intercalation, which undoubtedly indicate that it was implemented during the reign of Pīrūz, there is further evidence from a source of an entirely different nature: Pīrūz was the first Sasanian king to date his coins (2). The earliest dated Sasanian coin is from the third year of Pīrūz' reign (3), which coincided with the year of simultaneous two-month intercalation. This coincidence may be fortuitous, but it is also reasonable to assume that his introduction of coin-dating is an indication that he was sufficiently interested in time-reckoning in general to be responsible for the intercalation (4).

If we take the 190th year before the death of Yazdgird III, i.e. A.D.461 (651 - 190), when in all probability the double intercalation was carried out, as the reference point for our calculation of the Zoroastrian cycles of intercalation, we come to the conclusion that the beginning of the Zoroastrian calendar-year must have been relocated

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1. See Taqīzādeh (1317 H.S.), p.322; (1938), p.52; (1346 H.S.), p.111; the date given by Ibn Yūnus for the first astronomical observations by the Iranians is 360 years before the observations made under ʿAbbāsid Caliph al-Ma'mūn. Taqīzādeh ((1938), p.52) gives the date of these observations as A.D.833, despite the fact that A.D.833 was the year of Ma'mūn's death and that his observations must have been several years earlier (see Humā'i (1316-1318 H.S.), pp.161-164, n.1; Nallino (1349 H.S.), pp.231, 351-359).

2. Paruck (1924), pp.63, 75, 127, 197-198.

3. Ibid, p.101.

4. For further evidence on simultaneous two-month intercalation during the reign of Pīrūz, see also Section III.II.

in its original position after every 120 years (provided the intercalations were consistently and regularly practised)(1) both prior to and subsequent to A.D.461, i.e. in the years 18, 138, 258 B.C. and A.D.101, 221, 341, 581. Consequently, the year in which Zoroaster decreed an intercalation in the form of one complete month, and which, according to Bīrūnī's traditional account, was the date of the institution of the Zoroastrian method of intercalation, must have been 120 years prior to the date of the first intercalation, i.e. 258 + 120 = 378 B.C. This date, however, is nearly two centuries later than the latest date acceptable for the death of Zoroaster (2). Bīrūnī, who gives several different dates for Zoroaster's life-time, none of which would place his death later than 590 B.C.(3), was himself well aware that these dates are not in agreement with the date of the institution of intercalation in the Zoroastrian calendar as calculated from the number of intercalary cycles. He asserts that, while the 1218-year interval between Zoroaster and Yazdgird III justified 10 intercalations (4), eight intercalary months only were inserted during this period. Unless we cling to the traditional belief in the introduction of the intercalation system by Zoroaster, we can infer that the Iranians responsible for the invention of this method of intercalation introduced it several centuries later than the various dates given by modern scholars. Furthermore, the authors of the extant Pahlavi books had neither a clear knowledge of the elements of their calendar-structure nor of the precise date of their prophet's life-time (5).

It will be a considerable step forward if we can determine the original location of the beginning of the Zoroastrian calendar-year and the relationship between the Zoroastrian months and the astronomical seasonal points for the period in which this method of time-reckoning was in use. In previous sections, in which the early Iranian calendars up to the beginning of the Sasanian period were discussed, the earliest dated document in which the names of the month and month-days were given in Zoroastrian form was from the Arsacid period (see Section II.IV). Unfortunately, of the nearly 2800 documents discovered at Nisa, only three of those which have been published bear a date expressed in month and month-day, the majority of the ostraca

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1. See Ḥamza (1346), p.3, where he states that the Iranians had always intercalated the month up to and including the Sasanian dynasty; see also Table 5.

2. See Herzfeld (1933), pp.132-136; Christensen (1334 H.S.), pp.56 ff.; (1343 H.S.), pp.54-54; Yarshater (1336 H.S.), p.13; Boyce (1970), pp.537-538; cf. Boyce (1975), p.1, n.4.

3. Bīrūnī (1879), pp.17, 186, 196; (1352 H.S.), pp.24, 263-264, 503-504; (1956), p.131. See also Lewy (1944), pp.197 ff.; Taqīzadeh (1947), pp.33 ff.; cf. Bharucha (1900), pp.1, 11.

4. Bīrūnī (1373 A.H.,I), pp.131-132.

5. Much has been written over the past three centuries about the date of Zoroaster's mission, but no unanimous conclusion has yet been reached.

giving only the year. There is no reason to suppose that the method of time-reckoning is not uniform throughout the collection. As has already been mentioned, the earliest date on any of the Nisa documents is 76 A.E., corresponding to 172 B.C. (see Section II.IV). This does not necessarily imply that 172 B.C. represents the inception of the Zoroastrian calendar. The incompletely erased earlier texts, still partly legible beneath later inscriptions (1), indicate that some of the potsherds had been used previously, prior to the dates which were over-written later. Provided the erased texts are not evidence of subsequent corrections of clerical errors, the over-written documents imply that there were probably earlier dates on the erased texts. Bearing the earliest date of 76 A.E. (172 B.C.) in mind, together with the fact that there isnot a single document for the period between 76 A.E. and 144 A.E. (104 B.C.), nor for the isolated year 160 A.E. (88 B.C.)(2), which is in the middle of the 91-year period covered by the wine-cellar documents (144 to 235 A.E.; 104 to 13 B.C.), and further that the documents were discovered in different rooms of the wine-store without exhibiting any particular order or arrangement (3), we may infer that, when the documents were no longer required, they were erased or simply thrown away (4). It is reasonable to suppose that all the potsherds for document-less years, including an indefinable period prior to the earliest inscribed date, were erased or thrown-out at some later stage. It is therefore impossible to arrive at a precise date for the introduction of the method of time-reckoning employed at Nisa. Nevertheless, if the Nisa documents are considered in conjunction with the date on Avroman parchment III, and particularly the inscription of Artabanus V (c. A.D.213/4-226/7)(5), which provides valuable clues to the nature of the Zoroastrian method of time-reckoning, the inevitable conclusion is that the Zoroastrian year of 365 days, with one intercalary month in a cycle of 120 years, was first used by the Arsacids (6).

Dates suggested by eminent scholars for the institution of the Zoroastrian method of time-reckoning range from 3209 B.C.(7) to the

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1. Dyakonov and Livshits (1960,b), pp.14, 16.

2. Ibid, p.16.

3. Ibid, pp.14-15.

4. Ibid, p.14.

5. See Henning (1949-1952), pp.151-179. For the duration of Artabanus V's reign, see Simonetta (1956), pp.77-82; Sarkārātī (1353 H.S.), pp.342-344.

6. Cf. Cavaignac (1932), pp.2, 5; Bickerman (1967), pp.205-206.

7. See Bailly, apud Taqīzādeh (1317 H.S.), p.222, n.370, and apud Bickerman (1967), pp.200-201; also Kuka (1900), where the belief is expressed that the Iranians fixed their months in relation to the seasons more than six thousand years ago.

early Sasanian period (A.D.226)(1). The weaknesses of arguments in support of dates prior to the Arsacid dynasty have been discussed in earlier sections (II.I to II.IV and III.I). It should be added that the hypothesis put forward by Boyce, locating the introduction of the 365-day Zoroastrian calendar at the beginning of the Sasanian period, is based on her interpretation of Bīrūnī's record and various Pahlavi texts (2). There are certain passages in these sources which cast doubts on the attribution of the 360-day calendar to the Arsacid period and on the consequent inferences. The author of the Bundahishn, for example, discusses "The 180 apertures (rūzana)(3) on the east side and 180 apertures on the west side of the high peak of Mount Alburz"(4); Boyce makes this the basis of her assumption of the use of a 360-day calendar (5). The author of the Budahishn, in the same chapter and even in the same verse, consulted by the above author, states, after the last word of the above quotation, that "Every day the sun comes in through one aperture and goes out by another. The moon, the constellations and the planets all have connection with, and motion towards it (sic)...". In the same chapter (vs.4-7) appears the statement: "As it is in 365 days that it [the sun] goes forth from Aries and returns to Aries, and in those five "Gatha" [epagomenae] it comes and departs from the same light [aperture]"(6). An even more unambiguous definition of the length of the year appears in the same chapter (v.20), in which the author of the Bundahishn states: "...the point from where the sun had advanced up to the same point where it returned is reckoned as a year of 365 days, 5 hours and a fraction"(7). It would appear

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1. Cavaignac [1932], pp.2, 5; Boyce [1970], pp.517 ff., especially pp.522-523.

2. Boyce [1970], pp.515 ff.

3. The word "rūzana" is still in current use in Iran with the meaning "aperture". It is variously translated as "aperture" by West in the Bundahishn; as "light" by Anklesaria; by Boyce and Mackenzie ([1964], p.517) as "window".

4. Bundahishn [1880], Ch.5, v.3, p.22; [1956], p.65; see also Mackenzie [1964], p.517.

5. Boyce [1970], pp.515-516; [1975], p.135; cf. Taqīzādeh [1938], p.53; [1346 H.S.], p.112, where he states that the Bundahishn gives the length of the year (in Chapter 5) as 365 days, 5 hours and a few minutes (or a fraction of an hour). The same statement appears in Mehta [1950], p.15 and Mackenzie [1964], p.518.

6. Bundahishn [1880], p.24; [1956], p.65; see also Mackenzie [1964], p.518, in which this statement appears in the form "As, from when it [the sun] goes forth (Frazwardēd) from the first asterism [constellation] of the Lamb [Aries] until it reaches the Lamb [Aries] again, in 360 days and those 5 intercalary (gāhānīg) days".

7. Bundahishn [1956], p.69; see also Mackenzie [1964], p.521.

that the concept of 180 apertures on either side of the Alburz peak is less likely to be a definition of the year, but rather of the zodiac or ecliptic, which represents an imaginary circle commonly divided into 360 degrees of arc. The ecliptic is described by the author of the Bundahishn as "embracing the path of the sun, moon, planets and also constellations as observed from the earth"(1), which is in agreement with the definitions by Iranian authors of the eighth century A.D. onwards (2) and those appearing in several Pahlavi texts. A quotation from Yasht 12.25 (3): "...upon the peak of high Haraitī (Alburz), around which turn for me the stars and moon and sun", which appears in Boyce's recent (1970) article "On the Calendar of Zoroastrian Feasts" in support of her hypothesis of a solar year of 360 days, has even more recently been requoted by the same author, with a slightly modified wording, as "the peak of high Hara...around which circle the stars and moon and sun"(4). The word "circle", appearing in the alternative translation, in itself goes some way towards corroborating the interpretation of the "apertures" as "degrees of arc". Boyce has lately expressed the view that "the Indo-Iranians shared evidently an ancient religious calendar divided into 360 days"(5), adding in a footnote that "in ancient Iranian theory both sun and moon years were regarded as being 360 days in length"(6). The same book also makes reference to the Bundahishn's 180 apertures on either side of Mount Alburz. Notwithstanding Boyce's comment in her earlier work, which does not appear in this book (and which the present writer has been unable to discover in original texts), of "(the sun) passing through each window twice a year"(7), if the concept of 180 apertures is a definition of the year, the length of such a year will be 180 days, since, in her own words, "...and that the sun came through an eastern window each day at dawn, and passed back through a western one at night"(8) constituting ipso facto a day.

We have earlier discussed (Section II.I) Boyce's interpretation of Bīrūnī's traditional record of the Pīshdādian kings employing a 360-day calendar, where she claims that "In Islamic times royal use of this calendar was ascribed, according to al-Bīrūnī, to the mythical Pēšdādians; but that Parthian and Pēšdādian should be confused by the tenth century A.D. is not improbable".

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1. Bundahishn (1880), Ch.5, v.5, p.23; (1956), pp.65-66.

2. Mas'ūdī (1344 H.S.), p.88; Bīrūnī (1934), p.58; (1316-1318 H.S.), p.75; Rashan Yasht (1883), v.25, p.175; Dīnā-i Mīnu Khirad (1885), Ch.49, vs.12-27, pp.91-94 and Ch.57, v.13, p.100.

3. Rashan Yasht (1883), pp.91-94.

4. Boyce (1975), p.135.

5. Ibid, p.135.

6. Ibid, p.135, n.37.

7. Boyce (1970), p.516.

8. Boyce (1975), p.135.

Even if the kings mentioned by Bīrūnī in the above passage were the Arsacids, this still does not alter the fact that the Zoroastrian calendar was in use from the early Arsacid period. Boyce is also of the opinion that "there is no evidence or not of the epagomenae in the calendar of the Arsacids; but if, as the present data (Nisa documents) suggest...it seems possible that they adopted the 360-day religious year 'without modification'"(1). Taqīzādeh, whose opinion is not beyond question, had already pointed-out that "the year of 360 days was perhaps the first step in the transition from a lunar to a solar year, being half-way between 354 and 365 days"(2). It is hardly conceivable that the Arsacids, who paid special attention to matters relating to their calendar, establishing the Arsacid era for their own time-reckoning, and using their own era with the Macedonian lunisolar calendar (see Section II.IV), which implies familiarity with the length of the solar and lunar years, would have used in their documents a calendar of 360 days corresponding neither to the solar nor to the lunar year.

The Zoroastrian calendar of 365 days, which was in use during the early Arsacid period in the north-east of Iran (see Section II.IV), probably the traditional home of Zoroastrianism (3), gradually became popular in the west and south-west of the Arsacid empire after their conquest of western Iran and the continual westward transfer of the royal residence. The method of time-reckoning using the names of Zoroastrian months and month-days in conjunction with the Arsacid era, by which the inscription of Artābānus V is dated, must have been comprehensible to the inhabitants of south-west Iran. The date of this inscription, according to Henning, is "year 462 A.E., month of Spandarmat,

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1. Boyce (1970), p.517.

2. Taqīzādeh (1938), p.16, n.3; (1346 H.S.), p.68, n.3. While the sun appears as a bright circular disc, and its daily and yearly path in the sky, which is not always the same, governs the weather, vegetation etc., it is inconceivable that the primitive peoples could have paid attention to the path of the moon, the determination of whose period depends on knowledgeable observations of the sun's position. The quotation from Taqīzādeh's works appears in an earlier article, published by Paruck (1937), p.54, with the wording "...it is clear that the cycle of 360 (360-day calendar) represents the earliest attempt to make an adjustment between the lunar year of 354 days and solar year of 365 days".

3. Christensen (1334 H.S.), pp.80-83; (1343 H.S.), pp.3-6; Rawlinson (1969), pp.22-24; Rypka (1968), pp.4-5; Unvala (1914), p.9; Boyce (1975), pp.1-2, 7; cf. Bīrūnī (1352 H.S.), pp.541-543. This part of al-Āthār al-Bāqīya, which does not appear in the manuscript published and translated by Sachau, was published by Taqīzādeh in the Bulletin of the School of Oriental Studies, vol. 8, part 4, 1937, pp.947-954, and then by Dānāsirisht in the second edition of the Persian translation of al-Āthār al-Bāqīya, pp.541-548.

day of Mihr", for which he gives the equivalent Julian date 14th September, A.D.215 (1). If the year 462 A.E. is converted on the basis of a year of "360 days without modification", as Boyce suggests (2), the solution of the calculation will be some 2425 days (6 years, 7 months, 20 days) earlier than the corresponding date given by Henning. Since the earliest possible year for the accession of Artabanus V is universally accepted as A.D.212/3 (3), this result cannot be correct.

A factor which has generally not received detailed consideration, perhaps because the pioneers of research into matters relating to the Zoroastrian calendar tended to concentrate on the date of its institution, believing it to have been in a period in which Zoroastrianism flourished or during Zoroaster's life-time (4), is the existence of different methods of time-reckoning employed concurrently during the Arsacid period (see Section II.IV). Despite the fact that the subject has been discussed in previous sections, a further brief consideration of the various methods of time-reckoning then in use will demonstrate that the Zoroastrian method of time-reckoning with a 120-year intercalation-cycle could not have originated at any period other than the Arsacid. The Arsacids' original domestic time-reckoning, as the Nisa documents and the inscription of Artabanus V suggest, was a solar system of 360 days plus five supplementary days. This format of (12 x 30) + 5 = 365 was not adopted from the Egyptians, as many scholars claim (5): the 360 days, divided into 12 equal parts (months), was the conventional period for the passage of the sun, moon and planets through the signs of the zodiac, each 30-day sub-division (see above, p.93) being known even to the Vedic Aryans as early as the date of composition of the Veda (c. 1200 B.C.)(6). The five supplementary days had

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1. Henning (1949-52), p.176; see also Bickerman (1967), pp.204-205; Boyce (1970), p.517; Sarkārātī (1352 H.S.), p.344.

2. Boyce (1970), pp.516-517 and footnote 25.

3. See Simonetta (1956), pp.81-82.

4. See Taqīzādeh (1317 H.S.), p.19; (1346 H.S.), p.71.

5. Cavaignac (1932), pp.2-3; Paruck (1937), p.57; Taqīzādeh (1935), pp.2-7, 12, 17-23, 33, 37, 57. Taqīzādeh, who believes that the Iranians adopted the calendar of 365 days ((12 x 30) + 5 = 365) from the Egyptians, considered this question in numerous books and articles. Since this constitutes the very foundation of his study of the Iranian calendars, it is pointless making specific reference here. There are many other authors who also think that the Zoroastrian calendar was an off-shoot of the Egyptian calendar: see Report of the Calendar Reform Committee (1955), pp.166, 212; Mu'īn (1325 H.S.), p.1; Bulsara (1953), p.185, n.1; Brennand (1896), pp.9, 14; Gurgānī (2535 Sh.), pp.19-20; cf. Pīrnīyā (1344 H.S.), p.1498; Bickerman (1967), p.205.

6. Coyajee (1353 H.S.), pp.62-64; Brennand (1896), pp.9-14; Report of the Calendar Reform Committee (1955), pp.192-193; Bickerman (1969), p.56.

been added long before the Iranian historical period (1). When the Arsacids came to power, they adopted Seleucid (Macedonian) lunisolar time-reckoning, which had been in common use during the Seleucid period (see Section II.IV). Later, when they transferred their residence from the north-east of Iran to Babylon, they became familiar with the Babylonian 19-year lunisolar system. The Arsacids used these three different methods of time-reckoning with their own era, taking as their epoch the establishment of their kingdom (see Section II.IV). It is quite clear that over the long period of the Arsacid dynasty, the displacement of the Zoroastrian months and New Year's Day became quite perceptible in relation to the Babylonian and Macedonian months and New Year's Days, which were simultaneously in use. There was no need for astronomical observation of seasonal points. Even if the Arsacids had no clear knowledge of astronomy, the displacement of their months in relation to two other independent calendars was sufficient to demonstrate the inadequacy of their own method of time-reckoning. The shift of the Zoroastrian New Year's Day in the Babylonian calendar, in which the length of the year alternated between 354 and 384 days because of the intercalation of one month in every two or three years, was not considered abnormal within a limit of 27 days. The inadequacy of the Zoroastrian calendar due to neglect of the fraction of the seasonal year in excess of 365 days only became apparent when the deviation between the two calendars had accumulated to more than 27 days, a process which took nearly 120 years. In these circumstances, the only way to restore the Zoroastrian New Year's Day to its original location was to insert one month in one of the Zoroastrian years. This solution was fairly generally applied to contemporary calendars of the Arsacid period.

The above hypothesis can be supported by further evidence. The detailed information in the Nisa documents relating to delivery of wine and payment of taxes "in kind" shows that there must have been some sort of regulation concerning the date of payment of the tax and the delivery of the wine. If these were regulated by the date of the Zoroastrian calendar, as the Nisa documents suggest, consideration of the seasons was essential. To restore the date of payments of tax to the season in which the corn or grapes were harvested demanded some modification of the calendar year. Clearly, the insertion of one day in every four or five years was not practised, and no-one in those days was aware of the Julian method due to become popular in later centuries (2). Since the fraction of the seasonal year in excess of 365 days is less than one complete day, annual regulation was also out of the question. As will be mentioned in Section III.II, intercalation of the month in the Zoroastrian calendar was a matter of concern to peasants and government alike for tax-collection, rather than religious purposes.

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1. See Bīrūnī (1879), p.13; (1352 H.S.), p.18.

2. See Encyclopaedia Britannica (15th edition), vol.3, p.597.

III.II. The Zoroastrian calendar during the Sasanian period

The official method of time-reckoning during the Sasanian period was in fact the Zoroastrian calendar with a 120-year intercalation-cycle. Details of the method and date of the last and double intercalation in the Sasanian period have already been discussed (see Section III.I). Two major changes in the Zoroastrian method of time-reckoning which were made during this period have had a profound effect on Iranian time-reckoning up to the present day. Unfortunately, the "tampering" with the chronological history of the pre-Sasanian period, which is generally attributed either to Ardashīr or the Zoroastrian priests of the Sasanian period (1), and the attribution of the innovations to an earlier period by the contemporary and later Zoroastrian priesthood, probably in a quest for authority for the changes (2), have misled later historians, who have accepted Zoroastrian accounts at face value and have consequently arrived at various erroneous conclusions. These two major changes in the Zoroastrian calendar will be considered in more detail below. In the extensive literature on the subject, mainly written during the last two centuries, many authors have been guilty of misinterpretations. In view of this, specific references to this literature will not be made at every step in the argument.

The first of the changes relates to the reckoning of the years from the official coronation of the individual Sasanian kings, rather than according to the fixed era which had been used in Arsacid times. The Sasanians at the time of their accession to power adopted the Zoroastrian calendar of the Arsacid period with the exception of the use of the Arsacid era (3). They initially practised dating by a dynastic era, whereby they antedated the first year of the king's reign. The adoption of the dynastic era was in imitation of either the Seleucid or, more probably, the Arsacid dynastic era. The Sasanian kings subsequently began to date by regnal years, reckoning them from the first New Year's Day on which the king had been on the throne (4). The earliest dated document for this period is the Bishāpūr inscription (5), in which the date is given by the Sasanian

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1. This question is discussed at length by Lewy in an article published in J.A.O.S. (1944), pp.197-215; see also Browne (1929), pp.119-120; Taqīzādeh (1940-1942), p.128; (1346 H.S.), p.222; Frye (1976), p.200.

2. Christensen (1343 H.S.), pp.60-61, 75; Frye (1976), p.240.

3. Cf. Ginzel (1906), p.298.

4. See Bīrūnī (1879), pp.34, 39; (1352 H.S.), pp.48, 54; (1934), p.172; (1316-1318 H.S.), p.238; Ṭabarī (1352-1354 H.S.), p.135; Ḥamza (1346 H.S.), pp.17, 164; Ibn Athīr (1349 H.S.), p.9; also Paruck (1924), pp.27, 75, 101, 127; (1937), pp.74, 76, 78; Spuler (1952), p.480; Miles (1959), p.10, n.18.

5. Henning (1937-1939), pp.822-849; Sprengling (1937), pp.126-144; see also Taqīzādeh (1943-1946), p.7-8; (1346 H.S.), pp.234-235; Frye (1976), p.238.

dynastic era and the regnal years of Ardashīr (A.D.226-240), founder of the dynasty, and his son and immediate successor Shāpūr I (A.D. 240-272), at whose command the inscription was made (1). The inscription is dated "In the month of Farvardīn of the year 58 corresponding to 40 years of the 'fire' (era) of Ardashīr and 24 years of the fire of Shāpūr". The year 58 is reckoned from an era located 18 years prior to the official start of the reign of Ardashīr, probably from the year in which Ardashīr or his father Pāpak was appointed governor of Iṣṭakhr. There is no doubt that 18 years prior to Ardashīr's reign, or 32 years prior to the reign of Shāpūr I, the Arsacids were still in power and the Sasanians were not yet actually on the throne (2). The second and third eras, i.e. "40 years of the fire of Ardashīr" and "24 years of the fire of Shāpūr", obviously represent reckoning by the regnal years of Ardashīr and his immediate successor Shāpūr I. The "fire" referred to in the quotation is virtually the epoch: on the coronation day of the Sasanian kings, which traditionally took place on the Iranian New Year's Day (3), a fire (or rather "eternal flame") was kindled in their fire-temple (4). This reckoning by regnal years is identical to the method discussed earlier in connection with Achaemenian time-reckoning (see Section II.II), with the exception that during the Sasanian period the first year of the reign was identical to the last year of the previous king (5).

During the Sasanian period, regnal-year reckoning produced as many eras as kings. Reports left by post-Islamic authors concerning the reigns of the Sasanian kings are at variance. The epochs of those Sasanian kings whose reign-durations cannot be indisputably proved by calendar-facts have not yet been reliably determined (6), in spite of painstaking researches by many distinguished scholars. Among the dates given by present-day scholars for events in the early Sasanian period, the date 12th April, A.D.240, calculated by Henning for the coronation of Shāpūr I (7), is corroborated by unimpeachable sources,

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1. Henning (1937-1939), p.823; cf. p.845 of same work.

2. Ṭabarī (1352-1354 H.S.), pp.583-584; cf. Paruck (1924), p.74.

3. See Kūshyār, apud Ideler (1826), pp.247, 624-625; also Ginzel (1906), p.292; Paruck (1924), p.75; (1937), p.76; Taqīzādeh (1937), p.917; (1346 H.S.), p.181; the date given by Taqīzādeh for the end of the first year in which Yazdgird became king is incorrect.

4. Henning (1937-1939), p.847; see also Taqīzādeh (1943-1946), pp.7-8; (1346 H.S.), pp.234-235.

5. Paruck (1924), p.117.

6. Ṭabarī (1352-1354 H.S.), pp.584, 923; Ḥamza (1346 H.S.), pp. 17, 164; Bīrūnī (1879), p.39; (1352 H.S.), p.54; see also Paruck (1924), pp.11 ff.; Taqīzādeh (1943-1946), pp.6-19; (1346 H.S.), pp. 231-254; Zarrīnkūb (1343 H.S.), pp.220-221; Frye (1976), p.238.

7. Henning (1958), pp.116, 118; see also Sarkārātī (1352 H.S.), p.351.

and, despite Taqīzādeh's protestation to the contrary (1), is also consistent with calendar-facts. Ibn Nadīm, quoting an unknown Manichaean source, gives the date of the coronation of Shāpūr I as "Sunday the first day of Nīsan, when the sun was in Aries"(2). The approximate year-date of the coronation of Shāpūr I can be obtained from the Bishāpūr inscription; the corresponding Babylonian date is given by Elias of Nisibis for the beginning of Shāpūr I's reign (not his official coronation)(3); the latter is confirmed by several other sources. The available data for this event are week-day, month-day and approximate year-date; these inevitably produce the same date as that given by Henning. The date can be arrived at with absolute certainty either by retrogressive calculation or by using tables prepared on the basis of the relationship between days, weeks, months and years of different calendars (see Chapter V).

Taking the date of the coronation of Shāpūr I (Sunday 12th April A.D.240), which was the epoch of the regnal year of Shāpūr I, as a reference point for the early part of the Sasanian period (4), we can calculate the corresponding Julian dates for the epoch of the regnal year of Ardashīr and the epoch of the Sasanian dynastic era: 3rd April A.D.208 and 8th April A.D.226, respectively (5). The regnal-year epochs of other Sasanian kings up to Pīrūz, during whose reign (A.D.459-484) the second major modification to the official Sasanian time-reckoning was introduced, can be determined on the basis of reliable literary sources derived from old (probably contemporary) Pahlavi sources relating to the Sasanian method of regnal-year reckoning.

As has already been mentioned (see Section III.I, p.91), the year A.D.221, which is located within the "rule" of Ardashīr prior to his definitive victory over Artabanus V and his official coronation as "King of Kings of Iran"(6) and successor to the Arsacids, was the year in which the Zoroastrian-calendar intercalation was due. Provided the intercalation was in fact implemented during the reign of Ardashīr when it fell due, the Iranian New Year's Day would not have been very

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1. Taqīzādeh (1346 H.S.), pp.312-313.

2. Ibn Nadīm (1970), p.775; see also Taqīzādeh (1943-46), pp. 13-20; (1346 H.S.), pp.244-256; (1937-1939), pp.125-133; (1946 H.S.), pp.13-27.

3. See Elias of Nisibis, apud Henning (1958), p.112; Taqīzādeh (1943-1946), p.9; (1346 H.S.), p.236.

4. Henning (1958), p.118.

5. The date is given for the epoch of the Sasanian-dynasty era and the epoch of the era of Ardashīr under the assumption that no intercalation was implemented in the Zoroastrian calendar during this period.

6. See Ṭabarī (1352-1354 H.S.), p.584; Ḥamza (1346 H.S.), p.43; also Paruck (1924), pp.73-74; Frye (1976), p.237.

far from the Babylonian New Year's Day (and the sun's entry into Aries) during the early Sasanian period. Besides the date of the coronation of Shāpūr I given by Ibn Nadīm and others (see Section III.I), which falls in the spring and which must have been on the Iranian New Year's Day, and Bīrūnī's reports of the date of the double intercalation (see Section III.I), the report given by the author of Nawrūz-nāma also corresponds to the due date of the intercalation. The latter author states that "...until the time of Ardashīr who instituted 'Kabīsa' (intercalation) (the intercalation was already practised, according to the same author, but had been neglected from the time of 'Iskandar-i Rumi')(1) and celebrated (the festival) and wrote a testament (i.e. advice to his heir), and the people followed his rule until the time of Anushirwān the Just..."(2). A report identical to that of the Nawrūz-nāma appears in a later text, published together with an English "translation" in the K.R. Cama Memorial Volume in 1900 (3) (before the Nawrūz-nāma was printed and made accessible). The wording and format of the two reports indicate their common origin. The dates of composition of the two texts make it possible that the report given in the later text is derived from the Nawrūz-nāma, but not vice-versa (4). Unfortunately, incomplete comprehension of the Persian has led to mistakes in the later text and in its English translation (by F.M.R. Unvala), so much so that in places the meaning of the text has been completely changed. For example, Unvala translates the Persian "tā bi-rūzgār-i Ardashīr-i Bābakān ki Jashn-i 'kabīsa' uftād" تا بروزگار اردشیر بابکان که جشن کبیسه افتاد (5) as "when in his reign (Ardashīr's) the time for kabīsa (intercalation) fête arrived"(6), whereas a more correct translation would be: "...until the reign of Ardashīr, in which the feast of intercalation occurred". Assuming that celebration of the feast of intercalation implies actual intercalation, as appears to be the case according to Bīrūnī and others (7), Unvala's correct translation of the subsequent phrase "va jashn-i kabīsa na-kard" وجشن کبیسه نکرد (he did not perform 'Kabiseh' fête) constitutes a major contradiction. In view of the identity of origin of Unvala's Persian text and the corresponding passage in the Nawrūz-nāma, which also appears in a manuscript held in the British museum (8),

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1. Nawrūz-nāma (1312 H.S.), p.11.

2. Nawrūz-nāma (1312 H.S.), p.11; see also Taqīzādeh (1317 H.S.), p.127, n.267.

3. Unvala (1900), pp.235-238.

4. See Mīnovī (1312 H.S.), intro. pp.7-13; also Gandjei (1966), pp.235-237; Boyle (1975), pp.661-662.

5. Unvala (1900), p.235.

6. Ibid.

7. Bīrūnī (1879), p.54; (1352), pp.70-71. See also Mīnovī (1335 H.S.), p.86.

8. An identical passage appears in (Rieu, Add. 23, 568), folios. 89^a-89^b.

the prefix na "نه" (= not) in Unvala's text must have been added either by a scribe, or by Unvala himself in copying it, as a result of misunderstanding the earlier statement. Possibly because of the miswriting of the word "īwan" ایوان (palace) which appears as "Iran" in Unvala's Persian text, and the erroneous addition of the prefix na نه, the translator has omitted the following phrase from his English translation: "...tā bi-rūzgār-i Nushīrwān-i ʿādil rasīd va Iran-i Madā'in Tamām gasht" تا روزگار نوشیروان عادل رسید و ایران مدائن تمام گشت (...until the reign of Anūshirwān the Just when Iran (sic) of Madā'in was finished). Matters are made worse by Unvala's occasionally incorrect parenthetical explanations, which make his translation, at best, difficult to follow. Since this passage has become the foundation-stone of certain works on Iranian chronology (1), it warrants verbatim quotation (Unvala's original comments are in round brackets; those of the present writer are in square brackets):

> "When in his (Ardashīr's) reign the time for the "Kabiseh' fête arrived, he did not perform the 'Kabiseh' fête. Men followed this custom till the reign of King Noshirwan (i.e. did not perform the 'Kabiseh' during this interval). And the people from all the cities of Persia gathered together and performed the Navroz (Nawrūz) ceremony (i.e. the New Year's day ceremony), and celebrated (Kabiseh) fête as was their former usage"(2).

Since the original manuscript used by Unvala is at present inaccessible, a translation is given below of the same passage, from the (earlier) Nawrūz-nāma (3):

> "...until the time of Ardashīr who instituted intercalation (4) and celebrated (the) festival and wrote a testament (advice to his heir); and the people followed his rule until the time of Anūshirwān the Just, when the palace of Madā'in (Ctesiphon; Iwān-i Madā'in; Ṭāq-i Kasrā) was finished, then he (Anushirwān the Just) celebrated the Nawrūz and performed the ceremony of the festival in accordance with their rules, but he did not perform an intercalation."

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1. See Boyce (1970), p.532, where the author, quoting Unvala's translation, states that "In a later text it is explicitly said, however, that intercalation, although instituted in Zoroaster's lifetime, was not practised by Ardašīr Pāpakān, but was neglected by the Sasanians until the reign of Xusrau I".

2. Unvala (1900), p.236.

3. Nawrūz-nāma (1312 H.S.), p.11.

4. According to the author of Nawrūz-nāma, intercalation was already practised but had been neglected since the time of Iskandar-i Rūmī.

The underlined suggested corrections are supported by the date of the double-month intercalation determined in Section III.I, which, because of lack of attention to detail and misinterpretation by certain scholars, has been attributed to various kings. It is to be hoped, however, that this will henceforth be accepted as being during the reign of Pīrūz. Further evidence of the correctness of the re-translation is to be found in the location of the Iranian New Year's Day during the reign of Ardashīr: it had been restored to the spring (the sun in Aries on New Year's Day), by means of the intercalated month. This correction alone invalidates most so-called Zoroastrian calendars compiled by present-day authors.

As has already been mentioned, the second due date for intercalation during the Sasanian period was A.D.341. There is so far no direct literary record of this intercalation, but it is possible to prove conclusively that the intercalation took place in or around that year. Since we have evidence that a particular Iranian New Year's Day fell on Sunday, 12th April, A.D.240, when "the sun was in Aries", we can infer that, in A.D.221, the year of the first Sasanian-period intercalation, the New Year's Day had by that time not shifted far from the vernal equinox (its original location). The next recorded intercalation was in A.D.461, in which two months were intercalated: one at its appointed time, the other "in anticipation" of a possible oversight 120 years hence (see Table 5). Had there been no intercalation at or around the due date of A.D.341, three intercalary months would have been required, whereas there is no doubt that only two were intercalated. There is considerable evidence to support this: according to the passage from the Nawrūz-nāma and the equivalent passage from a later text, compared above, Ardashīr "instituted intercalation ...and the people followed his rule until the time of Anūshirwān". This implies that the intercalation was performed regularly in this part of the Sasanian period (1), and, since the intercalation whose due date was A.D.581 had been intercalated "in anticipation" in the year A.D.461, there was in fact no need for another intercalation in A.D.581 or even in the later part of the Sasanian period.

The second change concerned the location of the Iranian New Year's Day, which, as has already been mentioned, had been at or close to the vernal equinox during the Achaemenian, Arsacid and the first part of the Sasanian periods. This change was made during the later part of the Sasanian period (see below). Its date, and the consequent modifications of the Zoroastrian calendar, are recorded neither in contemporary Pahlavi texts nor in any post-Islamic sources. The facts are difficult to determine with precision, not only due to the lack of direct evidence, which can be countered to some extent by consideration of the position of Nawrūz and the Zoroastrian months in relation to the astronomical seasonal points recorded in available sources, but also to various other complex problems, which will be considered below.

The Pahlavi texts, which are the main sources for this period, are believed to have been "revised" several times in the light of

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1. See also Ḥamza (1346 H.S.), p.3; Mīnovī (1312 H.S.), p.87.

changes in religious doctrine and "for posterity". Considered linguistically, the texts constitute a semantic and syntactical "hotch-potch" spanning a period of several centuries. Such adulterated sources, particularly in view of the virtual impossibility of accurate interpretation of a dead language, are clearly unreliable in the context of precise dating (1).

Records in post-Islamic sources for the position of Nawrūz in relation to the astronomical points are unreliable, unless supported by calendar-facts.

In the post-Islamic period, Ardashīr and Kasrā (Anūshirwān the Just) became the focus for all institutions and organizations connected with the Zoroastrian church, all previous and subsequent Zoroastrian achievements being attributed to them (2). This rewriting of history (a not uncommon practice) included the attribution of the shift of Nawrūz to the summer solstice either to Ardashīr, the founder of the dynasty, who himself is said to be guilty of rewriting the history of his predecessors, or to Kasrā (Anūshirwān the Just), who was well-known as a devotee of Zoroastrianism (3). Most post-Islamic authors refer to every Sasanian king as "Kasrā". All these factors, together with the indisputable fact that the Iranian New Year's Day, which had been at or close to the vernal equinox in the early part of the Sasanian period, was moved during the later part, have contributed to differing interpretations by present-day authors.

Before proceeding to a study of the later Sasanian method of time-reckoning in the light of calendar-facts, let us first consider some of the erroneous interpretations proposed by present-day authors.

The first of these misinterpretations, which has been put forward by many historians, is that the beginning of the Iranian year (Nawrūz) in the Zoroastrian calendar, traditionally the advent of spring (i.e. the first point of Aries), was moved by eight months from its original location. Accordingly, they argue, there cannot have been any intercalation during the Sasanian or earlier periods, and the years must have been reckoned in the Egyptian fashion [(30 x 12) + 5 days], without intercalation (4). Such an interpretation is not corroborated by any of the relevant sources.

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1. See West (1880), pp.ix-xxviii; (1885), pp.xvi-xviii; also Anklesaria (1956), p.28; Christensen (1343 H.S.), pp.60-61, 75-76; Humā'ī (1340 H.S.), pp.101-103, 151-153; Ṣafa (1336 H.S.,I), pp.133-135.

2. Darmesteter (1880), p.xxxiii; Frye (1976), p.240.

3. Ṭabarī (1352-1354 H.S.), p.646; Mas'ūdī (1344 H.S.), p.258; Ya'qūbī (1347 H.S.), p.202.

4. Boyce (1970), p.529; see also Nöldeke, apud Paruck (1924), pp.74-75.

If one were to accept the improbable assumption that intercalation was not practised, the use of a year of 365 days, being almost six hours shorter than the seasonal year, would cause the beginning of the Zoroastrian calendar-year to regress by one day in every four years, by one month in 120 years and by eight months in 960 years. In view of this, and in view of the fact that during the latter part of the Sasanian period Nawrūz was celebrated in the summer, its location having been shifted in 461 A.D., scholars wishing to determine its original location have in the past had to rely on one of the dates available to them in the literature; they then made retrogressive calculations, placing the date of introduction of the Zoroastrian calendar several centuries too early (1). They also claimed that, at that date, Nawrūz was in its original (i.e. vernal) location. This hypothesis held for more than three centuries. However, the discovery of the Persepolis documents, which are dated by the lunisolar calendar, unearthed, "next door to the palace of Darius, Xerxes, and Artaxerxes"(2), has now completely ruled out the possibility of the adoption of the Egyptian calendar by the Achaemenid kings.

In the second mis-interpretation, which has also attracted much support, Nawrūz is said to have been followed by the five supplementary days, this combination being shifted from its original location by one month in every 120-year intercalation-cycle. Since the beginning of the Zoroastrian calendar-year was always in the same month (Farvardīn) as at the time of introduction of the Zoroastrian calendar, and since the reason for intercalation was to restore Nawrūz to its original location (see below), the supposition that Nawrūz was transferred to the beginning of successive months every 120 years means that the beginning of the calendar year was no longer at its original location. Such an interpretation is partly based on the supposed date of the introduction of the Zoroastrian calendar, which has been mistakenly attributed to different periods several centuries too early, and partly on the misunderstanding of the Zoroastrian intercalation-system. The latter was detected by Bickerman, who writes: "The Persian (Zoroastrian) intercalation has been misunderstood by modern scholars, who assumed that the change in the position of the epagomenae must have also moved the New Year's Day."(3).

More recently, a third interpretation has been made by Boyce (4), who assumes that a Zoroastrian calendar "in the Egyptian fashion"(5) was introduced during the early part of Ardashīr's reign (6). Besides

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1. Bickerman has discussed the weakness of such arguments: see (1967), pp.200 ff.

2. Gershevitch (1951-1952), p.133.

3. Bickerman (1967), p.200

4. Boyce (1970), pp.513-539.

5. Ibid, p.518.

6. Ibid, pp.518-524.

her "correction" of Bīrūnī's traditional account (see Section II.I), and use of Unvala's mistranslation of a later text (see above, p.102), there is a further statement by Boyce that "When the Sasanians came to power there existed evidently a scholarly and vigorous Persian priesthood; and a calendar reform is traditionally ascribed to Ardašīr Pāpakān, for the poet al-Buḥturī, speaking of a later calendar adjustment says: 'The day of Nō Rōz has returned to that time on which it was fixed by Ardašīr '"(1). In examining her interpretation of al-Buḥturī's "verse", which she has taken from Bīrūnī's "al-Āthār al-Bāqīya"(2), together with her statement elsewhere that "the intercalation was not practised by Ardašīr Pāpakān"(3), we must consider the situation at the time when al-Buḥturī composed this poem. According to Bīrūnī, during the reign of the Caliph al-Mūtawakkil (A.D.847-861; 232-247 A.H.), who considered moving Nawrūz because of the omission of the intercalation during the period of Arab dominance over Iran, the Caliph issued an order for the postponement of Nawrūz until 17th June (4), and al-Buḥturī composed an ode (qaṣīda) on the subject in praise of al-Mūtawakkil. According to the same author, al-Mutāwakkil was killed and his plan was not implemented (5). Since Bīrūnī goes on to show that none of the court astronomers had an accurate knowledge of the Zoroastrian intercalation and that their calculation of the original location of Nawrūz was consequently incorrect (6), the quotation from al-Buḥturī cannot be taken to mean that a reform took place. Provided that Buḥturī meant what he said and did not introduce Ardashīr merely for the sake of the rhyme, and provided also that the poet was familiar with the Zoroastrian method of time-reckoning, al-Buḥturī's, as well as Bīrūnī's evidence, would tend to refute Boyce's theory, rather than support it (7).

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1. Boyce (1970), p.518.

2. Bīrūnī (1879), pp.37, 377, Sachau's annotation on p.37, line 19; Bīrūnī (1352 H.S.), pp.52-53.

3. Boyce (1970), p.532.

4. Bīrūnī (1879), p.37; (1352 H.S.), pp.52-53.

5. Bīrūnī (1879), p.37; (1952 H.S.), pp.53-54; cf. Taqīzādeh (1937), pp.908-910; (1346 H.S.), pp.168-171.

6. Bīrūnī (1879), pp.37-38; (1952 H.S.), pp.53-54.

7. In the same article (p.527) Boyce states that "When Ardašīr made his postulated reform, he appears simply to have introduced the epagomenae before 1 'Fravardīn' as it then fell (which was in early autumn), without attempting to bring the holy days back into relation with their appropriate seasons." This contradicts al-Buḥturī's assertion that the Iranian New Year's Day was located in the summer during the reign of Ardashīr.

The three hypotheses mentioned above not only conflict with the most reliable relevant sources, but also fail to solve the difficulties associated with Zoroastrian-calendar dates in Pahlavi texts and post-Islamic sources.

A more credible interpretation, which would resolve all the as-yet-unanswered questions concerning the Zoroastrian calendar, has not yet been seriously considered, despite the wealth of supporting evidence. This hypothesis is based on the fact of the displacement of the Iranian New Year's Day from its original location at or near the vernal equinox (the sun's entry into Aries) to the summer solstice (the sun's passage of the first point of Cancer), a modification which was introduced at the time of the simultaneous two-month intercalation in A.D.461, during the reign of Pīrūz.

The modification of the original Zoroastrian calendar in A.D.461 did not replace, but co-existed with, the original system. The days, months, and years of the original system were qualified by either prefixing or suffixing "Vahījakīk" (also encountered in the form Bahīzakī, Vahīzakī, Naījakīk, Bihtarak and even Dīnī), to differentiate them from the modified calendar, which was eventually identified as "Kharājī". The meaning of the Pahlavi term "Vahījakīk" is a subject of controversy among linguists and has been variously translated into English as "auspicious", "rectified", "the better one", and "religious"(1). The equivalent English term for "Kharājī" is "land-tax"; it was applied to the calendar used for both land-tax collection and religious purposes. Bīrūnī gives the position of Nawrūz in his passage relating to the simultaneous two-month intercalation both as the advent of spring and the beginning of summer (2). According to Bīrūnī, the Persian people regarded the day of Hurmuz of the month of Farvardīn (i.e. the first day of the first month), when the sun was in Aries, as the start of their year, while the astrologers and others considered the year as beginning when the sun was in Cancer. Since the sequence of the six Zoroastrian Gāhanbārs given by Bīrūnī (see below) is based on the second assumption, and since on several occasions (3)

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1. See West (1880), pp.20-22, 91, 92, n.1, 94, 97; Taqīzādeh (1317 H.S.), pp.11-15, 229-230, in which the author discusses the various interpretations of the word "Vahījakīk". To those meanings mentioned by Taqīzādeh must be added "moving", which appears as the English equivalent in Boyce's article "On the Calendar of Zoroastrian Feasts" (1970), p.529.

2. Bīrūnī (1879), p.55; (1352 H.S.), pp.71-72.

3. Ibid; see also p.555 of Persian translation of al-Āthār al-Bāqīya (1953 H.S.), in which a part of this original source, which did not figure in the manuscript translated by Sachau, is translated into Persian. In this passage, Bīrūnī explicitly states that "the first day of the month of Farvardīn is Nawrūz, which, according to the Persian name of this day, means the first day of the new year; it coincided with the sun's entry into Cancer when the Iranians used to intercalate the years."

he gives a summer-time start to the year (sun's entry into Cancer), there seems no doubt that "the others" refers to a Zoroastrian school who performed their religious ceremonies according to the modified, i.e. Kharājī calendar. Although it is impossible to determine where the followers of this school lived, the accounts given by Bīrūnī indicate that the Kharājī calendar was used in most parts of Iran.

The dates given by the two separate calendars, i.e. Vahījakīk and Kharājī, in Pahlavi texts and post-Islamic sources indicate that the two calendar-years had different starting points but otherwise ran parallel.

In each of the two calendars, the first month was Farvardīn (though, unfortunately, the texts do not always give the appropriate suffix), and the sequence of the months was the same.

As the corresponding dates of both calendars given in Pahlavi and in post-Islamic sources from various periods indicate, the adjustment of the calendar at the time of the simultaneous two-month intercalation (A.D.461) involved no more than changing the name of the original Zoroastrian calendar-months, whereby the month Farvardīn (which had been the first month of the original Zoroastrian calendar) became Ādhar (the ninth month), and the month Urdībihisht (originally the second month) became Daī (tenth month), and so on.

The definition of the starting point of the Iranian calendar-year as the sun's entry into the constellation of Aries, together with the order of the Zoroastrian months (see Table 5), can be found in sources composed at different periods (1). Although there is no alternative sequence for the Zoroastrian months, the relationship between the Zoroastrian months (Vahījakīk and Kharājī) and the Gāhanbārs differs in the modified calendar from that of the original Zoroastrian calendar. The sequence of Gāhanbārs, which will be discussed at the end of this section, leaves no doubt about the sequence of the Zoroastrian months, their relationship to the astronomical seasons and the modification of the calendar in A.D.461. Among the abundant evidence for the location of the month Ādhar as the first month of spring (and not the first month of the Zoroastrian calendar-year), a report by Weï Shou, a Chinese historian of the sixth century A.D., is of great significance in the study of Iranian time-reckoning for that period. Kuka, while discussing this report, gives an incomplete equivalent Chinese calendar-date for certain Iranian festivals; he arrives at the correct conclusion that the advent of the spring (the religious Nawrūz) was celebrated only by the Zoroastrian priests of the sixth

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1. Kūshyār, apud Ideler (1826), pp.547-548, 624-626; Mas'ūdī (1344 H.S.), pp.554-556; Ya'qūbī (1347 H.S.), p.216; Dinkard (1900), vs.16-17, p.21; Bundahishn (1880), Ch.25, v.21, p.97; (1956), Ch.25, v.26, p.211; see also Bundahishn (1880), Ch.7, v.2, p.26, where the month "Tīr" is the fourth month and the "owner" of the constellation of Cancer, the fourth constellation from Aries; for this, see also Zatspram (1880), Ch.6, v.2, p.169; Desai (1900), pp.242-243; Modi (1922), p.458; Tārīkh-i Qum (1313 H.S.), p.145; see also Section IV.III of present work.

century A.D. on the first day of the month Ādhar, while the secular Nawrūz was celebrated on the first day of the first month Farvardīn (1).

It seems certain that the celebration of the advent of spring on the first day of Ādhar coincided with the first day of the first month of the Vahījakīk calendar (Farvardīn), and, if the Zoroastrian priests were anxious to celebrate Nawrūz at its proper location and not in summer, which was the beginning of the Kharājī year, it is reasonable to suppose that the Zoroastrians retained their original calendar with a spring-start and the original month-sequence beginning with Farvardīn.

Tables 6 and 7 give the relationship between the Zoroastrian months of both calendars and the Julian calendar for the two significant years A.D.462 (the year after the double-month intercalation) and A.D.632 (the era of the Yazdgirdī calendar).

In column 2 of Table 6, the Vahījakīk (original) sequence of the Zoroastrian months and the beginning of the calendar year, which was on the first day of the first month (Farvardīn) at or close to the beginning of spring, is derived from general consideration of the Pahlavi texts and post-Islamic literature. Objections to such a Zoroastrian-month arrangement have been made only by present-day scholars, who have evidently misunderstood the precise nature of the Zoroastrian calendar. In view of the comprehensive consideration given to this month-sequence by Bīrūnī and others, and data given in the present work in relation to the Zoroastrian Gāhanbārs (see pp. 113-114), no further evidence need be presented here.

The last column of Table 6 shows the relative position of the Zoroastrian months after the displacement of New Year's Day to the summer solstice, defined by post-Islamic authors as the time at which the sun enters the constellation of Cancer. The Pahlavi texts, which describe the Vahījakīk month of Farvardīn as the first month of spring, give the position of the month of Farvardīn in the modified calendar as the first month of summer (2). The date of the anniversary of the dath of Zoroaster is given in the Pahlavi book "Zatspram" by both calendar systems: its author gives the 11th day of the month Vahījakīk-Urdībihisht as corresponding to the 11th day of the month Daī of the modified calendar (3). Contrary to the opinions that both these months belonged to the same calendar (4) or that mistakes were

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1. Kuka (1914), pp.11-14; see also Kuka (1900), pp.71-72, n.29; Zīj-i Mufrad (O.1.(10)), fol.3^{b}.

2. See Kuka (1900), pp.56 ff.; Paruck (1937), pp.58 ff.; Taqīzādeh (1937-1939), p.132; (1346 H.S.), p.23; Boyce (1970), pp. 530-532.

3. Zatspram (1897), Ch.23, v.9, p.165; also footnote 4 on same page; see also Paruck (1937), p.64; Modi (1922), p.462; Taqīzādeh (1317 H.S.), p.14, n.34, p.231; (1937-1939), p.132; (1346 H.S.), p.23; Boyce (1970), pp.530-531.

4. Boyce (1970), pp.531-532.

made by various original-source authors (1), a simple count-back from the date given for the anniversary of Zoroaster's death gives the first day of both calendars as corresponding exactly to those derived from such independent and widely-separated sources as the Bundahishn, Mas'ūdī, Bīrūnī and Kūshyār (2).

Table 6 is supported by sufficiently abundant evidence to rule out the other alternatives suggested by present-day authors. The location of the epagomenal days, which is identical in columns 2 and 5 of Tables 6 and 7, is in itself sufficient evidence of the Nawrūz-shift and the accompanying month-displacement (but not month-rearrangement, as believed by certain scholars)(3). The five supplementary days, which had been located before the beginning of spring in the original Zoroastrian calendar, remained in that relative position, but moved from the end of the 12th month of the original calendar to the end of the eighth month of the modified calendar (but still before the spring!).

While Nawrūz of the original (Vahījakīk) Zoroastrian calendar was celebrated on the first day of the first month (Farvardīn), when the sun was in Aries, the New Year's Day of the Kharājī calendar fell on the first day of the same month (Farvardīn), but when the sun was in Cancer. The day in the Kharājī calendar corresponding to the original Zoroastrian New Year's Day was the first day of the month Ādhar, which was called by those using the Kharājī calendar the spring feast "Bahār Jashn"(4).

The validity of the above calendar-tables is supported by a wealth of evidence. Bīrūnī, the leading authority for the Sasanian period, explicitly states in his "al-Tafhīm" that "the month of Ādhar at the time of the 'Khusrawān' was the beginning of spring"(5). This, taken in conjunction with the definition of the Iranian Nawrūz given by Bīrūnī, on the same occasion and in several other passages, as "the first day of the month 'Farvardīn'"(6), undoubtedly implies that the beginning of the modified calendar-year (Kharājī calendar) was during the summer in the later Sasanian period (7). The term "Khusrawān"

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1. See Mehta (1940), pp.26-27.

2. See p.108, n.1 of present work.

3. Boyce (1970), pp.531, 534, 536.

4. Bīrūnī (1879), p.211; (1352 H.S.), p.563; see also Ginzel (1906), p.291; Modi (1922), p.465, where he states that "Bahār Jashn, i.e. the Jashn (feast) to mark the approach of spring, it was on the first day of the ninth month Ādhar."

5. Bīrūnī (1934), p.181; (1316-1318 H.S.), p.265; see also Mas'ūdī (1344 H.S.), p.554; Boyce (1970), p.529.

6. Bīrūnī (1934), p.180; (1316-1318 H.S.), p.253; (1879), p.201; (1352 H.S.), p.555; (1373 A.H.,I), p.71.

7. Bīrūnī (1879), pp.185, 201; (1352 H.S.), pp.261, 282.

used by Bīrūnī means "the Sasanian kings from and including Khusraw Anūshirwān the Just". Bīrūnī, like many other post-Islamic authors, differentiates the Sasanian period proper from that of Khusraw Anūshirwān the Just by using the term Sasanian for the dynastic period as a whole and the terms Khusrawān and Kasrā (Akāsira) for the later period of the dynasty (1). Bīrūnī gives the location of the Iranian New Year's Day at the time of "Kasrās" as the summer solstice, wherein he is in agreement with the author of Nawrūz-nāma and Kūshyār. According to Kūshyār, "...during the reign of Kasrā b. Qubād Anūshirwān, the sun reached Aries in the month Ādhar"(2). This implies that the month of Farvardīn of the modified calendar, which was the official time-reckoning at that time, was in the summer. From this, a false conclusion might be drawn that the displacement of the Iranian New Year's Day took place during the reign of Kasrā (Anūshirwān the Just) or his successors (3). There is, however, adequate proof that the position of the New Year's Day was changed at the time of the simultaneous two-month intercalation in A.D.461, during the reign of Pīrūz. Since the five supplementary days were placed at the end of the eighth month (Ābān) of the original calendar in A.D.461 (see Tables 6 and 7), the change in the position of the Iranian New Year's Day must have occurred in the same year.

Table 6 shows the corresponding Julian dates for the Vahījakīk and modified months for the year A.D.462. The Julian were obtained by retrogressive calculation from the epochs of the Yazdgirdī and Magian eras (see Sections IV.I and IV.II).

Calculation shows the Julian date corresponding to the first day of Vahījakīk-Farvardīn of the year A.D.462 to be 1st March. In the same table, the corresponding Julian date for the first day of Farvardīn of the modified calendar is 29th June. All the equivalent Julian dates in this table are, of course, one month earlier than the dates which must have been calculated by the council responsible for the intercalation, because they deliberately intercalated an extra month "in anticipation" (see Section III.I). On the false assumption that the anticipatory intercalation was not in fact accomplished, the corresponding Julian date of the first day of Vahījakīk-Farvardīn would be 31st March, and the first day of the month of Farvardīn of the modified calendar (Kharājī) would be 29th July.

After the requisite "anticipated" 120 years had passed, the definition of the Iranian New Year's Day as either "the sun in Aries on New Year's Day" or "the sun in Cancer on New Year's Day", referring to 31st March or 29th July, as given by post-Islamic authors, is entirely justified, because the New Year's Day of both calendars returned to its original (A.D.462) location in A.D.581, which was the date

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1. Ṭabarī (1352-1354 H.S.), pp.492, 645 ff. Ya'qūbī (1347 H.S.), p.219; Ḥamd Allah Mustawfī (1339 H.S.), pp.102-126.

2. Kūshyār, apud Ideler (1826), pp.547-548, 624-626.

3. Paruck (1937), pp.64 ff.; see also Taqīzādeh (1938), p.5; (1346 H.S.), p.56; Boyce (1970), pp.528 ff.

due for intercalation (see Table 8). The first year in which the first day of the Kharājī-Farvardīn corresponded to 29th July was, in fact, A.D.580, which is the year after the death of Anushirwān the Just (1).

As has already been mentioned, the exact correspondence of dates of the two separate calendars encountered together in independent sources from different periods indicates that the months of the two calendars continued to run in parallel for the entire duration of their use (see Tables 6 and 7). This is explained by the fact that the modified calendar was introduced in A.D.461, which was the year of the last implemented intercalation, and that there was no further intercalation of the Zoroastrian type thereafter (see Section IV.I).

Taqīzādeh's claim (2) that the correspondence between the months of the two separate calendars was applicable only to the particular year A.D.508 is, in the light of the above, no longer tenable.

The whole of the above argument leads naturally to a fairly convincing, but not absolutely certain, conclusion. Bīrūnī's account of the adoption of the summer solstice as the beginning of the year, where he claims that the summer solstice was adopted because it was easier to ascertain than the vernal equinox (3), may perhaps have some connection with his account of the simultaneous two-month intercalation in A.D.461. The council of mathematicians, etc., responsible for the intercalation, had presumably put forward the proposal, and the government, which entrusted the task to one of its ministers (Yazdgird-i Hazārī)(4), accepted the new system as the official time-reckoning. The new system, as Bīrūnī and other post-Islamic authors state, was actually preferred by the people because it was more suitable for the gathering of land-taxes than the original Zoroastrian calendar. There are many post-Islamic authors who assert that, during the reign of the "Kasrās", the starting date for the collection of land-taxes "in kind" had never been prior to the ripening of the fruit and corn (see Section IV.III). One of the several unsolved questions

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1. The author of Nawrūz-nāma states that "He (Anūshirwān the Just) ordered that these rules (celebration of Nawrūz and non-implementation of intercalation in the Zoroastrian calendar for the next 120 years, for which the intercalation had already been performed "in anticipation") should be continued until the beginning of the cycle (i.e. 120 years later) when the sun enters the constellation of Cancer". This further corroborates the summer-celebration of Nawrūz during the reign of Anushirwān the Just (see above, p.102).

2. Taqīzādeh (1937-1939), p.132; (1346 H.S.), p.23; see also Paruck (1937), p.75.

3. Bīrūnī (1879), p.201; (1352 H.S.), p.281.

4. Bīrūnī (1879), p.56; (1352 H.S.), p.72.

concerning the Zoroastrian calendar is whether the "revision" was specifically intended to bring the Zoroastrian traditions and feasts into line with the astronomical seasons, or whether the people in the south and south-west of Iran gradually came round to performing the Zoroastrian cermeonies according to the new calendar.

During the two centuries in which the Avestan and Pahlavi texts have been translated into European languages, many scholars have attempted to solve the difficulties surrounding the ancient and mediaeval Iranian calendars; they have been particularly concerned with the six "Gāhanbārs" (unequal seasons). For these, different scholars have given different sequences and durations, related to their various interpretations of the Zoroastrian calendar.

The most common Gāhanbār sequence is to be found in the Avesta, Vispered I (1) and Yasna I, II, II, IV, V, (2), and Khurda-Avesta (3), where there is a detailed explanation of their significance. The Khurda-Avesta explains that each of the six Gāhanbārs represents the completion by Urmazd (God) of one of the six stages of the creation of the world, and states that the five days of each Gāhanbār were devoted to a celebratory feast (4).

The significance of the six Gāhanbārs is given below on the basis of the Avesta in agreement with the early Zoroastrian calendar, in which the calendar-year began at or close to the beginning of spring.

1. Maidhyūizarimaya-Gāh (Mīdyūzarm)

"Urmazd created the sky in 45 days and celebrated the Gāhanbār in the month of Urdībihisht (second month) on the day of Daī-bi-Mihr (15th). The feast days were five days from Khur-Rūz (11th), the last day being Daī-bi-Mihr-Rūz"(5).

2. Maidhyūishima-Gāh (Mīdyūshahm)

"God created the water in 60 days and celebrated its creation in the month of Tīr (fourth month) on the day of Daī-bi-Mihr (15th); there were five feast days beginning on the day of Khur-Rūz (11th) and ending on Daī-bi-Mihr"(6).

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1. Avesta (1864), Vispered I, vs.2-6, p.5.

2. Avesta (1864), Yasna I, vs.26-31, p.27; Yasna II, vs.36-40, p.33; Yasna III, vs.40-45, p.37; Yasna IV, vs.31-37, p.41; Yasna V, vs.27-32, p.44; see also West (1880), p.91, n.5, p.92, n.2, 3.

3. Avesta (1864), Afrīn-Gāhanbār, vs.14 ff., pp.180 ff.; see also Darmesteter (1883), p.192, n.1.

4. See Ginzel (1906), p.283; Boyce (1970), p.525.

5. Avesta (1864), Afrīn-Gāhanbār, v.14, pp.180-184.

6. Ibid, pp.181-182.

3. Paitishhahya-Gāh (Patyashahīm)

"Urmazd created the Earth in 75 days and celebrated the Gāhanbār, giving it the name Gāh Paitishhahaya, in the month Shahrīvar (sixth month). The feast days lasted from the day Ashtād (26th) until Anaghra (Anīrān; 30th)"(1).

4. Ayāthrima-Gāh (Āyasarim)

"God created the plants in 30 days and celebrated the Gāhanbār in the month of Mihr (seventh month) on the day of Arshtāt (Ashtād; 26th). The feast lasted from that day until Anīrān-Rūz"(2).

5. Maidhyāirya (Mīdyarim)

"Urmazd created the animals in 80 days and celebrated their creation in the month of Daī (tenth month) on the day of Mithra (Mihr; 16th). The feast lasted until Virithraghna-Rūz (Bahram; 20th)"(3).

6. Hamaspathmaīdhya (Hamaspatmadam)

"God created man in 75 days, whereafter he celebrated the Gāhanbār at the end of Ispandārmadh (Isfand; 12th month), on the day of Ahunavaītī (first epagomenal). The feast lasted from the first epagomenal day till the fifth Vahistuīsht (4).

The five supplementary days, during which the celebration of the sixth and last Gāhanbār was performed, are named after the five Gathā as Ahunavaītī, Ushtavaītī, Spintamaīnyū, Vuhkhshathra and Vahīshtuīsht (5).

While the sequence, duration and the month-days of the Gāhanbārs given in the Avesta and the Bundahishn (6) are in agreement with regard to the earlier Zoroastrian calendar, by which the calendar-year began at or close to the start of spring, there is between them a divergence

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1. Avesta (1864), Afrīn-Gāhanbār, v.16, p.182.

2. Ibid, v.17, p.183.

3. Ibid, v.18, p.183.

4. Ibid, v.19, p.184.

5. Bundahishn (1880), Ch.5, v.7, (1956), Ch.56, v.6, p.65. See also Doostkhāh (1343 H.S.), p.334.

6. Bundahishn (1956) Ch.1[a], vs.14-21. The sequence and duration of the Gāhanbārs, which Humā'ī in his edition of al-Tafhīm (pp.261-262, n.4) quotes as being from Bīrūnī's al-Āthār al-Bāqīya, is in fact in agreement with that of the Bundahishn. The Avesta and Bundahishn sequence appears in many works of the 11th century A.D. onwards.

of eight months (or four months, depending on the direction of measurement) as they appear in Bīrūnī's work. For example, the Maidhyūizarimya-Gāh, the first Gāhanbār, with its feast-days situated according to the Avesta and the Bundahishn in Urdībihisht (second month), are located by Bīrūnī in the month of Daī (tenth)(1). Various scholars have attempted to explain the discrepancy, but none of the explanations appears convincing (2).

A more probable explanation is that the month-names in the Avesta and the Bundahishn are from the early Zoroastrian-calendar used by the clergy even after the modification of the calendar in A.D.461, while those given by Bīrūnī belong to the modified calendar, by which the corresponding dates of the six Gāhanbārs of the original calendar are given.

From an examination of Table 9, which represents the sequence of Gāhanbārs appearing in the Avesta and the Bundahishn, and Table 10, which reproduces them as they appear in Bīrūnī's works, it will be observed that the two calendars run in parallel; this confirms the modification of the Zoroastrian calendar in A.D.461.

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1. Bīrūnī (1879), p.212; for the sequence and duration of the five other Gāhanbārs as given by Bīrūnī, see pp.205-217 of same work. See also Mullā Muẓaffar (1267 A.H.), Bāb 15th; (Ethe 2247), fol.69^{b}.

2. For various interpretations relating to the sequence, duration and calendar employed, see Nadershah (1900), pp.257-262; Taqīzādeh (1317 H.S.), pp.44-46, 51, 65, 72, 101-111, 145-148; (1938), pp.25-33; (1346 H.S.), pp.77-86; (1952), pp.206-211; (1346 H.S.), pp.402-409; Lewy (1941), p.14, n.1; Boyce (1970), pp.515 ff.

CHAPTER IV

Post-Islamic Iranian calendars

Study of post-Islamic Iranian methods of time-reckoning (other than the Arabian lunar-Hijrī calendar) shows that six different calendars were used, and all were basically derived from the two separate Zoroastrian calendars of the Sasanian period (see III.I and III.II). The evidence presented here may in fact be used to support the arguments in those sections relating to the Zoroastrian calendars of the earlier period. Details of the Iranian post-Islamic calendars can be determined without much difficulty, thanks to the existence of a considerable quantity of relevant material, added to which the science of astronomy, on which calendars are based, developed appreciably during the same period. Astronomical terms used in contemporary records have more or less their twentieth-century meanings and require no explanation or interpretation. The accuracy of the reports of historians on the subject of each of these calendars can be examined alongside reliable astronomical tables. The fact that dates are often given by two or more calendar-systems and different eras, in contracts, official government records, and eye-witness accounts, is sufficient to provide precise definitions of these calendars. The task is facilitated by the fact that for this period of nearly 1400 years, the epochs of the eras used by the various calendar systems are fixed dates, which have already been indisputably ascertained by historians and astronomers. Reckoning by regnal years, which constitutes a problem in the study of time-reckoning in the Achaemenian and Sasanian periods, was no longer practised during the post-Islamic period. Various modifications to the two original Zoroastrian calendars produced six different calendars in the course of the Islamic period.

The Zoroastrian month-names, although subject to variations in orthography and pronunciation, depending on geographical location and historical period, have remained basically unchanged up to the present day. The position of the months in relation to the astronomical seasonal points was changed several times during the period, but the sequence has remained unaltered since these months came into use. Various features are common to two or more of these six calendars, but each calendar is sufficiently distinctive to merit individual consideration.

In addition to these six different Iranian calendars, several "alien" calendars and eras were used at various times in the post-Islamic period, some of which are still in use. Apart from the three well-known non-Iranian calendars, i.e. Julian, Gregorian and Arabian lunar-Hijrī, which, by virtue of their international significance, are inevitably used as a reference in the conversion of Iranian calendar-dates, these imposed alien calendars will not be considered in the present work.

IV.I. The Yazdgirdī calendar

The era of Yazdgird is qualified variously by post-Islamic authors as "Tārīkh-i pādishāh shudan-i Yazdgird", "Tārīkh-i Yazdgird", "Yazdgirdīya", "Yazdjirdīya", "Yazdjirdī", "Yazdgirdī","Tārīkh-i Fārsī (Pārsī)", "Tārīkh-i Furs -i Qadīm" (Iranian or Persian era) and "Tārīkh-i Shahrīyārī"(1). The epoch of the Yazdgirdī era is the first Iranian New Year's Day (1st Farvardīn) of the reign of Yazdgird III (2). This day fell on Tuesday, 16th June, A.D.632, corresponding to 22nd Rabī‘ I, A.H.11, a date which has been reliably determined by many post-Islamic astronomers and historians and is universally accepted by present-day authors (3). The era of this Yazdgirdī calendar is, of course, not the same as the era of the Zoroastrian (Magian; Fārsīya) calendar to be discussed in Section IV.II.

It is nevertheless not a simple task to prove the validity of the equivalent Christian and lunar-Hijrī dates given above for the epoch of the era of Yazdgird on the basis of authoritative post-Islamic writings on the question. The position of the epoch of the era of Yazdgird in relation to nine other well-known eras is given by post-Islamic historians and astronomers either in years (of differing lengths), months, week-days and hours (4), or simply as the number of days between the two eras; while some of the sources are in agreement, there are small or considerable deviations in most of the intervals given. The nine eras, which are occasionally used as reference points in dating, comprise:

1. The epoch of the era of "Ṭūfān" (Deluge or Flood). Kūshyār (5) places the era of Yazdgird 1,363,597 days after the era of the Deluge,

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1. On the various names given to the Yazdgirdī era, see Tārīkh-i Qum (1313 H.S.), pp.242-244; Bīrūnī (1878), pp.142, 203; (1879), pp. 138, 184; Ḥamza (1346 H.S.), p.217; Mas‘ūdī (1344 H.S.), p.548; Tārīkh-i Banākatī (1348 H.S.), pp.24-25; Naṣīr al-Dīn Ṭūsī (O.2(7)), fol.13; (1330 A.H.), Faṣl, 5th; Ulugh Beg (1847), p.307; Bīrjandī (Ethe 3227), Fol.17[a]; Mullā Muẓaffar (1267 A.H.), Bab. 2nd, Section 3; see also Ideler (1826), pp.518-519; West (1882), p.xiv; Ginzel (1906), p.298; Nallino (1349 H.S.), p.230; Taqīzādeh (1936), pp.917-918; (1346 H.S.), pp.180-182; Spuler (1952), p.481; Bihrūz (1331 H.S.), p.34; (1347 H.S.), p.18.

2. Ibn Muthannā (1967), p.20; Pingree (1968), p.43; Ulugh Beg (1847), p.303; Rabī‘ al-Munajjimin (Sepahsālār 661), p.101.

3. Ideler (1826), pp.520, 543; Ginzel (1906), p.298; Paruck (1924), p.121; (1937), p.77; Humā’ī (1340 H.S.), p.362; Taqīzādeh (1937), p.917; (1346 H.S.), p.181; Walker (1941), p.xxvii.

4. See Pingree (1968), p.40.

5. Kūshyār, apud Ideler (1826), pp.626-627; see also Historical Tables from the Creation to 1680 (Ethe 2730), Fol.7[b]. Cf. Bihrūz (1331 H.S.), p.88.

whereas Bīrūnī (1) gives 1,363,598 days for the same interval. The figure given by Hāshimī (2) is the same as Bīrūnī's.

2. The epoch of the era of Bukhtnaṣṣār (Nabunaṣṣar). According to Mas'ūdī (3), the interval between this era and the epoch of the era of Yazdgird îs 510,725 days; Bīrūnī gives 503,425 days (4).

3. The epoch of the era of Philip. The interval between the epoch of this era and that of Yazdgird is given by most post-Islamic authors as 384,665 days.

4. The epoch of the era of Iskandar (Seleucid era). The position of the era of Yazdgird in relation to the Seleucid era has already been discussed (see Section II.III).

5. The epoch of the era of Augustus (Octavianus). According to Bīrūnī in "al-Tafhīm"(5), the interval between this era and the era of Yazdgird is 241,232 days, but the same author gives the figure 239,530 days in "al-Āthār al-Bāqīya"; Kūshyār calculates it as 241,281 days (6).

6. The epoch of the era of Diocletian. Kūshyār gives a time-difference of 126,968 days (7). According to Bīrūnī (al-Āthār, p.133), the interval is 125,082; in al-Tafhīm (p.170), it appears as 136,909 days.

7. The epoch of the era of the Hijra. The epoch of the era of Yazdgird is placed either 3623 or 3624 days after that of the Hijra (see below).

In addition to the above epochs prior to the epoch of the Yazdgirdī era, reference is frequently made to epochs of subsequent eras.

8. The epoch of the era Fārsīya (the Magian era). The epoch of the era of Yazdgird is placed exactly 20 complete Yazdgirdī years (20 x 365 = 7300 days) before the epoch of the era of Fārsīyā (see Section IV.II).

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1. Bīrūnī (1879), p.133; (1352 H.S.), table between pp.40 and 41.

2. Pingree (1968), p.40.

3. Mas'ūdī (1344 H.S.), p.548.

4. Bīrūnī (1879), p.133; (1934), p.170; (1316-1318 H.S.), p.241.

5. Bīrūnī (1934), p.170; (1316-1318 H.S.), p.241.

6. Kūshyār, apud Ideler (1826), pp.626-627.

7. Ibid, pp.626-627.

9. The epoch of the era of Mu'tadid. This era is placed 96,055 days after the era of Yazdgird (see Section IV.III).

It is evident from the intervals given above that, even allowing for scribal errors in copying original sources, there is an appreciable lack of agreement among post-Islamic authors on the subject.

If one accepts the validity of one or more of these statements, which Taqīzādeh claims to be different, although derived from a common source (1), one arrives at a date for the epoch of the era of Yazdgird which is very likely to be inaccurate, as was the case with the era of Iskandar (the Seleucid era) (see Section II.III). The reason for this is not, of course, lack of agreement on the epoch of the era of Yazdgird itself, which can be determined by use of chronological formulae provided by post-Islamic authors, or, even more precisely, by retrogressive calculation from one of numerous dates with its equivalent in other calendars, whose accuracy is confirmed by adequate evidence. The problem rather concerns differing beliefs relating to the dates of remote eras, i.e. the era of the Creation and the era of the Deluge (see p. 62), and the more important matter of the interval between the two epochs of the eras, on which post-Islamic astronomers and historians are unanimous with regard to relative location, but for which they give an interval varying by at least one day. For example, the equivalent dates of the epochs of the eras of the Hijra (1st Muḥarram 1 A.H.) and Yazdgird (1st Farvardīn 1 Y.E.) can be derived from Bīrūnī and Ulugh Beg (2) as 16th July A.D.622 and 16th June 632, while the interval between these two eras is given by the same two authors as 3623 (3) and 3624 (4) days, respectively. Both authors admit to reckoning the interval from a Thursday, which is the epoch of the era of Hijra as reckoned by astronomers (hollow months) (see Section I.II); but it appears from their calculations that Bīrūnī reckoned from a Thursday (the era of the Hijra) up to, but not including, the Tuesday, which is the epoch of the era of Yazdgird, whereas in the Zīj-i Ulugh Beg, as in many other sources, the Tuesday (epoch of the era of Yazdgird) is counted as one of the days of the interval between the two eras. Nevertheless, the epoch of the era of Yazdgird as Tuesday, 1st Farvardīn (Nawrūz) of the first year of the reign of Yazdgird III, was the reference point of official time-reckoning during the reign of this king, as was the case with the epoch of regnal years employed

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1. Taqīzādeh (1940-1942), p.124; (1346 H.S.), pp.215-216.

2. Ulugh Beg (1847), pp.296, 303.

3. Bīrūnī (1879), p.133.

4. Ulugh Beg (1847), p.307; see also Kūshyār, apud Ideler (1826), pp.626-627; Ibn Muthannā (1967), p.18; Mas'ūdī (1344 H.S.), p.548; Naṣīr al-Dīn Ṭūsī (O.2(7)), fol.14^{b}; Zīj-i Khāqānī (Ethe 2232), fol.7^{a}; Bīrjandī (Ethe 3000), Fol.14^{b}. Cf. Taqīzādeh (1317 H.S.), p.4, n.11.

by earlier Sasanian monarchs (1). Since Yazdgird was the last Sasanian king, the Iranians continued to count the years from the era of Yazdgird during the post-Islamic period, and those Iranians who have remained loyal to their ancestral religion do so up to the present day (2). The calendar used with the era of Yazdgird was the same as the official (Kharājī) calendar of the later part of the Sasanian period (see Section III.II). In this calendar, the year of 365 days was, and is, divided into 12 months of 30 days and five supplementary days, which were added after the eighth month (Ābān)(3); during the later part of the Sasanian period (A.D.461-652), this month was close to the vernal equinox (see Tables 6 and 7). During this period, in which the month Farvardīn (the first month of the year) was located in summer, as the equivalent dates of Nawrūz for the years A.D.632 and 652 indicate (16th July; 11th July)(4), the month Ādhar (ninth month), following the epagomenae, was at that time close to the vernal equinox. As a result, certain recent authors have supposed that Ādhar was the first month of the calendar (5), even though there is, in fact, no evidence to support this assertion for <u>any</u> period.

The intercalation of one month in every 120 years, which had been implemented for the last time in A.D.461 (see Chapter III), was not practised during later periods (6). Consequently, the beginning of the Yazdgirdī calendar-year, and the position of the months, was not fixed in any particular season; they thus advanced by one day every four years in relation to the Julian calendar, returning to their original location in relation to the seasonal year after 1508 years.

There are certain present-day authors who mistakenly believe that an intercalation was implemented in the Yazdgirdī calendar in A.Y.375 (= A.D.1006). Paruck, misled by a passage in Kūshyār's astronomical book "...until the year A.Y.375 of the Yazdgirdī era, where the sun entered Aries on the first day of the month Farvardin"(7),

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1. Ṭabarī (1352-1354 H.S.), p.135; Ḥamza (1346 H.S.), pp.17, 164; Bīrūnī (1879), pp.35-36; (1352 H.S.), p.50; Rabī' al-Munajjimīn (Sepahsālār 661), p.101; see also Walker (1941), pp.xxvi-xxvii, xxxv.

2. Taqīzādeh (1937), p.917; (1346 H.S.), pp.180-181; Walker (1941), pp.xxvii, xxxv; Muḥīṭ Ṭabāṭabā'ī (1354 H.S.), p.12.

3. <u>Zīj-i Mufrad</u> (0.1(10)), fol. 3^{a-b}; see also Tables 6 and 7 of present work.

4. See Spuler (1961), p.38.

5. Boyce (1970), pp.529 ff.

6. Cf. Rīyāḍī Kirmānī (1352 H.S.), p.303.

7. Kūshyār, apud Ideler (1826), pp.547-548, 624-625; see also Taqīzādeh (1317 H.S.), p.144, n.297.

asserts that "thus there was an intercalation of four months in the ecclesiastical year..."(1). Bulsara, incorrectly quoting the same passage from Kūshyār at third-hand, repeated the same erroneous assertion many years later (2); Boyce has done likewise in writing: "Some further development took place in Islamic times in the Zoroastrian calendar..."(3); this development "is to be found in the adjustment of the calendar which took place c. A.D.1006. In this year, Farvardīn, being once more a spring month, the religious Nō Rōz was moved forward to coincide again with the Nō Rōz ī Jamšēdī. All other days of obligation moved forward also through three months ..."(4) In the same article (p.527) she lists four supposed reforms in the Zoroastrian calendar, the third being "the shifting back of Nō Rōz to 1st Farvardīn c. A.D.1006, again with moving of the holiest festivals". No sources for this assertion are given, and there is ambiguity in the use of the terms "moved forward" and "shifting back", both relating to the same year A.D.1006. Regardless of the direction of this claimed displacement of Nawrūz, or whether the time-interval was four months (Paruck; Bulsara) or three months (Boyce), there is really no evidence to support the supposition of these authors. Fortunately, for the period under consideration, there is a wealth of evidence which permits accurate determination of the location of Nawrūz over the period of 1346 years up to the present day, in which the Yazdgirdī calendar has been used.

Ya'qūbī, the historian and geographer of the ninth century A.D., who in all probability lived until A.H.284 (A.D.897)(5), explicitly states that "the beginning of the Iranian year is Nawrūz, i.e. the first day of Farvardīn, which falls either in Nīsan or Adhar, when the sun has entered Aries, and this day is the great Iranian festival."(6). He was also familiar with astronomy (7); giving the months in relation to astronomical seasonal points, he gives the position of the months Isfandarmādh, Farvardīn and Urdībihisht as the three months of spring (8). Although Ya'qūbī attributed this situation to the past, other evidence indicates that this was the position of those months during Ya'qūbī's own life-time (9).

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1. Paruck (1937), p.65.

2. Bulsara (1953), pp.188-189.

3. Boyce (1970), p.535.

4. Ibid.

5. See Spuler (1349 H.S.), p.29; Āyatī (1347 H.S.), intro., pp.17-19.

6. Tārīkh-i Ya'qūbī (1347 H.S.), pp.216-217.

7. Āyatī (1347 H.S.), intro., p.13.

8. Tārikh-ī Ya'qūbī (1347 H.S.), p.216.

9. See Taqīzādeh (1317 H.S.), p.143, p.143, n.297.

Assuming that Ya'qūbī wrote his book, which is now known as "Tārīkh-i Ya'qūbī"(1), during the last 25 years of his life (A.D.872 to 897)(2), the Iranian New Year's Day (Nawrūz) must have fallen between 12th and 20th April (3), i.e. almost one month after the advent of spring, and Farvardīn must have been the second month of spring during this period.

Nearly a century later, the historian Ḥamza of Isfahan (d. between A.H.350 and 360; A.D.961 and 971)(4) recorded that "on the morning of Nawrūz of A.H.332 (=A.D.944), the people of Isfahan woke to see the land covered in snow in such abundance as had not been seen in spring before and were obliged to sweep the roofs"(5). A more precise location of Nawrūz in relation to the astronomical seasonal points for this period can be obtained from equivalent dates given by the same author by two calendar systems. For example, Ḥamza gives the date of Ḥasan b. Būya's conquest of Isfahan as "Monday 1st Rabī'I A.H.323, corresponding to the day Amurdād, month Isfandarmādh (7th Isfandarmādh)"(6). The equivalent Julian date for this event is 10th March A.D.935; the succeeding Nawrūz of the Yazdgirdī calendar must therefore have been on 3rd April A.D.935 (7). Although the table of equivalent dates for Nawrūz given by Ḥamza in the lunar-Hijrī calendar is, according to Spuler, not exactly reliable (8), the dates in the text relating to events in Isfahan and Ṭabaristān during his life-time are mathematically accurate.

The location of Nawrūz of the Yazdgirdī calendar in relation to the astronomical points can also be ascertained by the use of chronological formulae (for the conversion of Yazdgirdī calendar dates to other calendar dates) given by post-Islamic historians and astronomers, writing both before and after A.D.1006 (9). A study of the evidence given in their works and of many other available sources, including the corresponding dates given in the present-day Iranian almanacs, does not lead to any advance on the already-perfect Wüstenfeld-Mahler

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1. Āyatī (1347 H.S.), intro., p.24.

2. Ibid, pp.26-27.

3. See Spuler (1961), tables, p.38.

4. See Spuler (1349 H.S.), p.29; Shear (1346 H.S.), intro., p.12.

5. Ḥamza (1346 H.S.), p.179.

6. Ibid, p.217.

7. Spuler (1961), table on p.38.

8. Spuler (1952), pp.483-484.

9. See Chapter V; also Khareghat (1930), pp.119 ff.

comparative tables (1). All make it perfectly clear that no intercalation was ever implemented in the Yazdgirdī calendar (not to be mistaken with the Zoroastrian calendar of the early Sasanian period) (see Chapter III). Modern authors, such as Paruck, Bulsara and Boyce, have failed to grasp the significance of a very simple fact, which has long been known, namely that Nawrūz would, as a result of the length of the Yazdgirdī calendar-year (365 days without intercalation), gradually move forward (one day in nearly every four years) in relation to the Julian calendar, with the result that Nawrūz, after coinciding with 16th June A.D.632, would coincide with 11th June A.D. 652 and 15th March A.D.1006. The latter date is the equivalent Julian date of Nawrūz in A.D.1004, 1005, 1006 and also 1007. The reports of Ya'qūbī and Ḥamza, in conjunction with the demonstrable accuracy of the Wüstenfeld-Mahler tables, shows that there could not have been a three or four-month intercalation in A.D.1006.

It has already been mentioned that, during the later Sasanian period (A.D.462 to 652), the two different calendars in use, i.e. the official (Kharājī) and religious (Vahījakīk), were distinguished by two features: the location of the five supplementary days and the location of Nawrūz. Particularly in the first three centuries of the post-Islamic period, in which Zoroastrianism was under attack from the Moslem invaders and also from the Iranian Moslem converts, the official Sasanian calendar, either with the era of Yazdgird or the Kharājī era (see Section IV.III), nevertheless survived and was even used by the Iranian Moslems with the era of Yazdgird. Indeed, up to the present day, it is still shown in the annual Iranian almanacs. On the other hand, in spite of the claim made by Paruck, Bulsara and Boyce (2), there are no relics of the Zoroastrian religious or ecclesiastical calendar from this period. It seems probable, in view of the complete absence of evidence, that the Vahījakīk (religious) calendar was not even used during the reign of Yazdgird. Neither Zoroastrian nor any other books refer to the epoch of the era of Yazdgird given by the Vahījakīk calendar, whose equivalent lunar-Hijrī and Julian dates would be 19th Dhu'l-Qa'da A.H.10 and 16th February A.D.632. The Kūshyār passage, which has been misinterpreted by various authors (3), clearly shows that the calendar in question was the official Zoroastrian calendar with the Yazdgirdī era, whose New Year's Day, 1st Farvardīn, happened to coincide with the sun's entry into Aries in A.D.1006. This is the same calendar system, with which, during the reign of Anūshirwān the Just, the sun entered Aries in its ninth month (Adhār) (see Chapter III). The peculiarity of the year A.Y.375 (= A.D.1006), mentioned by Kūshyār, as is explicitly stated in a footnote in the Wüstenfeld-Mahler tables (4), is that in that particular year the location of the five

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1. See Spuler (1961), table on p.38.

2. See Paruck (1937), p.55; Bulsara (1953), pp.188-189; Boyce (1970), p.535; also Taqīzādeh (1317 H.S.), p.365; Bihrūz (1331 H.S.), p.56.

3. See Taqīzādeh (1938), p.5; (1346 H.S.), p.56.

4. Spuler (1961), table on p.40.

supplementary days, which in the official calendar was between the months Ābān and Ādhar (eighth and ninth), was moved to the end of the twelfth month, as in the Vahījakīk calendar; this does not necessarily mean, however, that the Vahījakīk calendar was in use or that in this year Nawrūz was moved by means of intercalation. The displacement of the epagomenae from the end of the eighth month was not accepted by the people of all the provinces of Iran (1). Since Kūshyār, who is the source of the record of the shift of the five supplementary days in A.Y.375 (= A.D.1006), does not give the name of the person responsible for the operation, and since in this period of time several independent or semi-independent monarchs ruled in different parts of Iran, present-day authors have attributed this operation to different kings without supporting evidence (2). While historians and astronomers of the early post-Islamic period up to A.D.1006 give the location of the epagomenae as the end of Ābān (eighth month)(3), it is claimed by most Iranian authors of later centuries that the Zoroastrians and some of the Moslems who adopted the Yazdgirdī calendar kept the epagomenae either at the end of the month of Ābān or Isfandārmadh, whereas the astronomers, who are well aware of the nature of this method, added the five supplementary days at the end of the year after the month Isfandārmadh (4). In a page of a calendar for the year A.Y.966, which appears in "Sharḥ-i Bīst Bāb-i Mullā Muẓaffar", the author, who himself was a court-astronomer during the reign of Shāh ʿAbbās I (A.H.996-1038; A.D.1587;1629), gives the equivalent date for 25th Murdād A.Y.966 as 1st Farvardīn A.Y.519 (= 10th March A.D.1597 o.s.; 20th March n.s.). This indicates that even an astronomer kept the five supplementary days at the end of the month of Ābān, although it might have been expected from certain passages in his writings that he would locate the epagomenae at the end of Isfandārmadh. Iskandar Munshī, the contemporary historian of the same period (A.D.1560-1633), dealing with the events of the year of "sīchqān" (mouse) A.H.1021 (= A.D.1612-1613), gives the location of the epagomenae, as celebrated by the people of Gīlan, after the three months of spring (5). Assuming that New Year's Day of the Yazdgirdī calendar in A.H.1021 coincided with 14th October, the five supplementary days actually fell on 21st to 25th June. The location

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1. Bīrjandī (Ethe 2237), fol.23^{b}.

2. Taqīzādeh (1317 H.S.), p.365; (1937), pp.917-918; (1346 H.S.), p.182, where the king responsible is given as "Bahā' al-Dawla". The same operation is attributed to Qābūs b. Wushmgīr by Bulsara ((1953), p.191). See also Bihrūz (1331 H.S.), p.56.

3. Yaʿqūbī (1347 H.S.), p.216; Kūshyār, apud Ideler (1826), pp.547-548; see also Kuka (1900), pp.71-72.

4. Naṣīr al-Dīn Ṭūsī (O.2(7)), fol.13^{a}; al-Simmānī (Add.11,636), fol.4^{b}; Zīj-i Ulugh Beg (1847), p.303; Qūshchī (1330 A.H.), Bab. 9th; Mullā Muẓaffar (1276 A.H.), Bab. 35d.

5. Iskandar Munshī (1350 H.S.), p.835.

of the epagomenae, together with dates given by the Yazdgirdī calendar alongside dates of other calendars in the writings of historians and astronomers up to the present day, indicate that attempts to change the position of the epagomenae, like attempts to fix the Yazdgirdī New Year's Day in relation to the astronomical seasonal points, were never fully accepted by the people, and that the calendar remained in use in its original form.

At the present time, the Yazdgirdī-calendar dates which are given in Iranian astronomical almanacs are in this form, except that the names of the month days are abandoned in favour of consecutive numbers (1). These calendars are called "Taqwīm-hā-yi Nujūmī" or "Fārsī"(2) and are composed by authors who usually refer to themselves as "munajjim-bāshī" (astronomers). The months of the Yazdgirdī calendar, which are the same as in the official Iranian calendar, are qualified by the suffix "Fursī"(3), and in some calendars by "Furs-i Qadīm"(4) or "Bāstānī"(5), e.g. "Farvardīn" is written as "Farvardīn-i Fursī" or "Farvardīn-i Fursī-yi Qadīm"; we sometimes find "Farvardīn-i Bāstānī" and "Urdībihisht" as "Urdībihisht-i Fursī", "Urdībihisht-i Fursī-yi Qadīm" or "Urdībihisht-i Bāstānī", and so on.

The first day of the Yazdgirdī calendar of A.Y.1346 is given in calendars of the above type as 28th July A.D.1976, which is exactly the same date as that given in the Wüstenfeld-Mahler tables, in which the corresponding date for 1st Farvardīn A.Y.1346 is given as 15th July A.D.1976 (o.s.). The five supplementary days of the same year are placed after the eighth month (Ābān), and correspond to 24th to 28th March (inclusive), A.D.1977.

Dates according to a so-called "Yazdgirdī calendar" are also given in a second category of annual calendars, namely those published by the Zoroastrian community of Iran. The calendar published annually by the Zoroastrian Association of Tehran is in the main imitated by

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1. According to Khareghat ([1930], p.121), prior to A.D.1866, the Yazdgirdī-calendar dates given in Zoroastrian calendars published by Zoroastrians in India were given in the form of consecutive numbers, rather than the names of month-days.

2. See Rajā'ī (1353 H.S.), pp.188-191.

3. See "Annual Fārsī Calendars", self-styled: "Dānishmand-i Mu'aẓẓam al-Hāj Shaykh 'Abd al-Nabī Kāshifī-yi Khurāsānī Munajjim-bashī". In these calendars (or almanacs) the Yazdgirdī month-names appear in the heading of each column with the suffix "Qadīm-i Pārsīyān". See also "Taqwīm-hā-yi Nujumī", composed by "Dānishmand-i Mu'aẓẓam Āqā-yi Ḥabīb-Allāh Nujumī b. Marḥūm-i Munajjim-bāshī".

4. See "Sālnāma-yi Fārsī", annual calendars composed by "Dānishmand i Mu'aẓẓam Janāb Āqā-yi Ḥāj 'Abbās Miṣbāhzada".

5. Annual calendars of the Zoroastrian Association of Tehran.

the others, but although it may therefore be regarded as the official Zoroastrian calendar, it is not universally accepted by Zoroastrians, either in Iran or elsewhere. The nature of this supposed Yazdgirdī calendar is apparent from the information usually printed in the introductory pages or from a consideration of the dates given in the calendar itself. As is the case with the "genuine" Yazdgirdī calendar, the year is divided into 12 months of 30 days and five supplementary days, which are added at the end of the twelfth month.

The epagomenae include the solar-year day-fraction discrepancy, which has varied over the years in such annual calendars between 5 hours, 48 minutes, 45.7 seconds (1) and six complete hours (2). In the official Zoroastrian calendar for the year A.Y.1342, whose New Year's Day is said to correspond to Wednesday, 1st Farvardīn H.S. 1352, 15th Ṣafar A.H.1393 and 21st March 1973, it is stated that, "since the solar year is of 365 days and nights, 48 minutes and 49 seconds, when the twelve months being finished, there remain 5 hours, 48 minutes and 49 seconds, called in Pahlavi 'Bahīzak' and in Fārsī (Persian)'Panja'". According to the same sources "Bahīzak is that which is called what other calendars call 'Kabīsa' (intercalation), and is of five days in every three years, and in the fourth year, when the fraction would accumulate to one day, or more than one day, it will be of six days, the sixth day being called in Pahlavi 'Avardād'"(3). There is nothing to be gained by dwelling on this definition, which is not authoritative; the word "Bahīzak" has already been discussed (see Chapter III); the name Avardād for the 366th day of a leap year is a unique innovation and invention (4). It is

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1. See the annual calendar of the Zoroastrian Association of Tehran for the year H.S.1346: the corresponding Christian and lunar-Hijrī dates for that year are given as A.D.1967/68 and A.H.1386/87, while the Yazdgirdī year, which should appear accordingly as A.Y. 1336/37 is given merely as A.Y.1336, which is both inadequate and misleading.

2. See the annual calendar of the Zoroastrian Association of Tehran for the year H.S.1343: on the cover, the corresponding dates are given as A.Y.1333 and 2500"Shāhanshāhī". The era and the method of these so-called"Shāhanshāhī"dates are manifestly arbitrary as the figures used over the years show. For example, on similar calendars for different years, the corresponding"Shāhanshāhī"year-dates for A.Y.1341 and 1342 are given as 2522 and 2523, respectively.

3. See Khareghat (1930), pp.125-126, p.128, n.1. According to this author, in Pahlavi and Pāzand the form Avardād is often used for Khurdād. Khareghat is sceptical of Cama's interpretation of "Avardād" as "the last time or day of the year".

4. See Khareghat (1930), pp.124-130. The names of the five supplementary days given alongside the five Avestic hymns in the same group of calendars also imply that the word Avardād is an innovation for the 366th day of each fourth year.

curious that in this category of calendars employing this definition, the indicated order of the leap years is not in fact adhered to. The actual order on which these calendars are based, as those published for the last 12 years clearly illustrate, is the same as in the official Iranian calendar of today, which follows the Jalālī calendar of the eleventh century A.D. (see Section IV.IV). The beginning and end of this so-called Yazdgirdī calendar also coincides with the beginning and end of the present official calendar; the only difference is in the names of the month-days and the length of the months. Adherents to these semi-official Zoroastrian calendars are referred to as Faṣlī (1) to distinguish them from two other Zoroastrian sects called Qadīmī and Shāhanshāhī (or Rasmī). Disputes between these three groups have been the subject of numerous articles and books (2); their differences of opinion will therefore be considered only briefly below.

It was in A.Y.1090 (A.D.1720) that an Iranian Zoroastrian priest by the name of Jāmāsp Ḥakīm Vilāyatī, on his arrival in Surat (one of the Zoroastrian centres in India), discovered that the calendar of his co-religionists in India, which should have corresponded to the calendar in use in Iran, was one month out: New Year's Day, and, by the same token, the months of the Iranian version, began one month earlier than in the calendar being used by the Zoroastrians in India (3). Much argument ensued, and in A.Y.1114 (A.D.1745) a few of the Zoroastrians in Surat, and some years later a few more Zoroastrians in Bombay, began to perform religious ceremonies according to the Iranian version of the calendar and called themselves Qadīmī (4), while those who continued to observe the Indian version adopted the name Shāhanshāhī (5). Since the difference between the two calendars was attributed to a one-month intercalation in the Indian version some time in the 11th or 12th century A.D.(6), the dispute soon led

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1. It seems that the Faṣlī sect follow the eminent Zoroastrian scholar Cama, who put forward the theory of one-day intercalation in the early Zoroastrian calendar. The appellation of the 366th day of leap years as Avardād is also his invention; see Edwardes (1923), pp.151-152; also Khareghat (1930), pp.124-130; Gharavī (2535 Sh.), p.50.

2. See Fīrūz b. Mullā Kāvūs (1196 A.Y.), pp.1 ff.; Patel (1900), pp.117-182; Khareghat (1930), pp.124-130; Paruck (1937), pp.71-73; Storey (1933), p.459; Taqīzādeh (1317 H.S.), p.148, n.303; Mehta (1940), pp.29-30.

3. Patel (1900), pp.175-176; Williams Jackson (1925), p.47; Paruck (1924), p.121; (1937), pp.71-72.

4. Patel (1900), p.176.

5. Williams Jackson (1925), p.47. According to Khareghat ((1930), p.120, n.3), the Shāhanshāhī calendar was unknown outside India.

6. Fīrūz b. Mullā Kāvūs (1196 A.Y.), p.3; see also Williams Jackson (1925), p.47; Paruck (1937), p.71; Bulsara (1953), p.193; Boyce (1970), p.537.

to argument over intercalation in general (1). The Qadīmī sect, who were in a minority in India, were supported by their co-religionists in Iran, in opposition to the Shāhanshāhī sect; they tried to prove that intercalation in the Zoroastrian calendar was not permitted and consequently claimed that it had not been practised during the Sasanian period (2). Both sects sought historical evidence to support their beliefs, rather than find out the truth. The literature published by both sects is riddled with religious fanaticism and can mislead the unwary student of this field (3). Consequently, when studying the Zoroastrian calendar for any period, care must be taken to avoid being influenced by deliberate misinterpretation of original sources, even when (as is sometimes the case) it is supported by slightly modified original texts from earlier periods (4).

The last point regarding the Yazdgirdī calendar which requires explanation is that raised by Bihrūz. The epoch of the era of Yazdgird, which he believed has no connection with Yazdgird III (5), was placed by him 545 years 43 days before the epoch of the era of Ṭūfān (Deluge)(6). According to Bihrūz, "the era which is written as Bukhtnaṣarī in astronomical tables is Yazdgirdī in all of the narrative"(7). These statements, placing the era of Bukhtnaṣar before Ṭūfān, are made without a single supporting reference. Other statements by the same author are rather puzzling: for example "Ṭūfān is put in astronomical books as 3735 years, 10 months and 22 days before the era of Yazdgird, which makes altogether 3736 years."(8)..."From the 1st Farvardīn of the era of Bukhtnaṣar till the Tuesday of the first year of departure (the author means the era of Fārsīya), according to astronomical tables is 503,355 days"(9)...

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1. Fīrūz b. Mullā Kāvūs (1196 A.Y.), p.4; Patel (1900), pp.175 ff.; Mehta (1940), pp.1-2.

2. Fīrūz b. Mullā Kāvūs (1196 A.Y.), pp.4 ff.; Patel (1900), p.180.

3. A list of the sources to which both sects refer is given by Patel. Not only are some of the sources manipulated by both sects: reference is even made to Sharḥ-i Bīst Bab-i Usturlāb by Naṣīr al-Dīn Ṭūsī to support the existence of Kabīsa, whereas the book makes no mention of intercalation at all!

4. Fīrūz b. Mullā Kāvūs (1196 A.Y.), pp.3 ff.

5. Bihrūz (1331 H.S.), pp.30, 34; Rīyādī Kirmānī (1352 H.S.), pp.303-304.

6. Bihrūz (1331 H.S.), pp.85, 88.

7. Ibid, pp.82-84.

8. Ibid, p.85.

9. Ibid, p.84.

"From Thursday 1st Farvardīn in the year of Ṭūfān till Tuesday 1st Farvardīn the era of Yazdgird is 1,363,640 days"(1). The logic of arguments presented in the above quotations and of Bihrūz' calculations (2) is difficult to follow; since his assumptions are not supported by adequate evidence, we do not need to pursue the matter further (3).

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1. Bihrūz (1331 H.S.), p.135.

2. Ibid, p.30.

3. For a comprehensive demolition of Bihrūz' claims, see Muḥīṭ Ṭabāṭabā'ī (2535 Sh.), p.375.

IV.II. The Magian era (Fārsīya)

Yazdgird III, the last Sasanian monarch, was murdered during the twentieth year of his reign (1); while some Iranians continued to reckon the years by his regnal years even after his death, others adopted a new era, starting from the first subsequent New Year's Day, i.e. 1st Farvardīn A.Y.21, corresponding to 11th June A.D. 652 (27th Shawwāl A.H.31)(2). This date is derived from the precise date of the epoch of the era of Yazdgird, as given by Bīrūnī and others (see Section IV.I) and from the chronological relationship formulated by Bīrūnī himself: "If we wish to find 'Tārīkh-i Majūs' (Magian era), we subtract twenty years from 'Tārīkh-i Yazdgird' (the era of Yazdgird)"(3). The same result can be obtained with any of the dates given by Ḥasan b. Muḥammed b. Ḥasan Qummī in Tārīkh-i Qum (4). The accounts given by these two authors, each of whom states that this calendar was in use during his life-time in his home-land, i.e. in North-East and Central Iran, indicate that this calendar was exactly in parallel with the Yazdgirdī calendar; if we have a date expressed in terms of month-name, month-day and year of the Yazdgirdī calendar, its corresponding date by the Magian calendar will be the same in month-name and month-day, but the year will be less by 20 years.

As in the above quotation, Bīrūnī calls this calendar Tārīkh-i Majūs, whereas the author of Tārīkh-i Qum refers to it as Fārsīya. In addition to these two names, Taqīzādeh has used the expression Tārīkh-i Ṭabarī, since he had initially believed it to be used by the native rulers of Ṭabaristān (5), but with a difference of one year between the Ṭabarī and Magian eras (6). The equivalent Christian date of the Ṭabarī era is given by Taqīzādeh as A.D.650 on the basis of his own questionable assumptions (7). He later revised his view: "The Magian era was in general use in Ṭabaristān and was most probably the same as the so-called Ṭabarī era"(8). In the same article, he

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1. Bīrūnī (1879), pp.123-128; (1352 H.S.), pp.165-175; in five different tables for the duration of the reigns of Sasanian monarchs, Bīrūnī gives that of Yazdgird III as 20 years. See also Ṭabarī (1352-1354 H.S.), pp.2145-2146; Ibn Athīr (1349 H.S.), p.301; also Paruck (1924), pp.119-120; Walker (1941), p.xxxv. Cf. Bihrūz (1331 H.S.), pp.34-37.

2. Ḥamza (1346 H.S.), p.59; Tārīkh-i Ya'qūbī (1347 H.S.), p.216, n.1; Ḥamd-Allāh Mustawfī (1339 H.S.), pp.126-127. Cf. Bihrūz (1331 H.S.), pp.34-38.

3. Bīrūnī (1879), p.138; (1352 H.S.), p.187; (1373 A.H.,I), p.142.

4. Bīrūnī (1879), pp.184-185; (1352 H.S.), pp.260-261; Tārīkh-i Qum (1313 H.S.), p.242.

5. Taqīzādeh (1317 H.S.), pp.179-180, n.339.

6. Ibid, p.179.

7. Taqīzādeh (1317 H.S.), pp.179-180, n.339. Cf. Paruck (1924), p.122.

8. Taqīzādeh (1937), p.919; (1346 H.S.), p.185.

also states that "The real name of this era, by which it must have been called by those who used it in the first century of Islam, is not known"(1). In a postscript to the same paper, referring to the only mention of the word Pārsīk after a year-date known to him at the time (out of the 20 or 30 accessible in Pahlavi literature), appearing in the Bundahishn manuscript published by Anklesaria as "978 Pārsīk after 20 Yazdgird", Taqīzādeh's inexplicable conclusion is that "the real name of the era was Pārsīk, that it was expressed by the words '20 years after Yazdgird' written after the Magian date"(2). In 1962 the same author wrote that "The Ṭabarī year or Tārīkh-i Ṭabarī is exactly the same as 'Tārīkh-i Fārsīya (Pārsīk)' or 'Tārīkh-i Majūs' and there is not a year's difference between their eras"(3); furthermore he states in the same work that the name Ṭabarī cannot be substantiated (4). In his last reference to the subject, in 1963, in an article published both in Irānshahr and subsequently in "Maqālāt-i Taqīzādeh", he states that Yazdgirdī eras from the date of Yazdgird's enthronement and from the date of his death (wafāt) were simultaneously used in some of the provinces. The latter was used by the ruler of Ṭabaristān and the Moslem governors of this province until A.H.163. In the same article, he asserts that "some of the 'Farangī' (European) authorities, unaware of the nature of this calendar, have called it Ṭabarī"(5).

In 1941, Walker opted for the description "Post-Yazdgird era", abbreviated to "P-Y.E.", which he believed was more appropriate (6). More recently, Miles (7) used the same term in a contribution to "The Cambridge History of Iran, (Vol.4)". Bihrūz distinguished two calendars: Tārīkh-i Majūs, whose era he places in A.D.656, and Tārīkh-i Yazdgirdī-yi Riḥlat (the Yazdgirdī era of departure)(8), whose era he locates 25 years before the era of Majūs (A.D.651)(9). Bihrūz' statement about the Yazdgirdī calendar is not supported by evidence provided by historians of earlier centuries; furthermore, using Bihrūz' own calculation, the results for the equivalent dates of the two above eras do not correspond to those he himself calculated (the accession of Yazdgird is located by the same author in the same book in A.D.673)(10).

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1. Taqīzādeh (1937), p.918, n.2; (1346 H.S.), p.183, n.1; a part of this footnote does not appear in the Persian version of the same article.

2. Taqīzādeh (1937), p.922; (1346 H.S.), p.189.

3. Taqīzādeh (1346 H.S.), p.548.

4. Ibid.

5. Iranshahr, Tehran,(1963)(Persian text), p.262; Taqizadeh (1349 H.S.), p.196.

6. Walker (1941), pp. xxvii, xxviii, lxx.

7. Miles (1975), p.364.

8. Bihrūz (1331 H.S.), pp.31, 35.

9. Ibid, p.54.

10. Ibid, p.38.

To the names given by the above authors to the calendar must be added "The era of the Zoroastrians" and "the Magorum era", both of which are used by Sachau in "The Chronology of Ancient Nations" as the equivalent of Bīrūnī's Tārīkh-i Majūs (1). Geldner, in the section of his prolegomena to the Avesta on the method of dating by the Magian era, after examining most of the dates given by the Magian era on the colophon of Pahlavi manuscripts, follows Sachau in calling the Magian era the "Zoroastrian era"(2). According to Geldner, "the oldest quotable instance of this era is the colophon of Mahvindād, the first transcriber of Dinkard, A.D.1020"(3). This manuscript is dated day Dīn (24th), month Tīr of the year 369 "after 20th year of Yazdgird"(4) (reckoning from 11th June A.D.652), corresponding to 2nd July A.D. 1020 (5). The expression "after 20th year of Yazdgird" is appended to the dates when they are calculated from the year A.D.652, but in some manuscripts of later centuries the suffix to the Magian date appears as "Pārsī after 20th year of Yazdgird"(6). Certain dates in the same group of manuscripts carry the qualification "Pārsī year" with no mention of "the 20th year of Yazdgird". In such a case, however, the colophon of this group of manuscripts is dated by the Yazdgirdī calendar and Magian era; Geldner and West have reached the same conclusion: that this is intended as the Magian era (7). The abbreviation used by Geldner for dates of the Magian calendar is "A.20.Y.", the form also adopted in the present work.

The Magian calendar never became as popular as the Yazdgirdī calendar. Even during the first two centuries of the post-Islamic period, at which time the Magian calendar was in most widespread use, the Yazdgirdī and lunar-Hijrī calendars were more generally used, even in the cities and provinces in which the Magian calendar was in use. The comparatively large number of extant coins minted in the various provinces and cities during this period include only a few bearing dates by the Magian calendar. Apart from Ṭabaristān, for which almost all the coins of the Spahbadān, and later the Arab

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1. Sachau (1879), pp.138, 184; cf. Bīrūnī (1878), pp.142, 203.

2. Geldner (1891-1896), p.iii, n.1.

3. Ibid.

4. West (1892), p.xxxiv; cf. Geldner (1891-1896), p.iii, n.1.

5. The corresponding Christian date appearing in West and Geldner is mathematically accurate, whereas the corresponding Julian date of the Magian era given by Geldner is one year less than the correct date.

6. West (1892), p.xxxv; Geldner (1891-1896), p.iii, n.1; Anklesaria, apud Taqīzādeh (1937), p.922; (1346 H.S.), p.189.

7. Geldner (1891-1896), p.iii, n.1; West (1892), p.xxxv, n.1.

governors, are dated by this calendar (1), a few coins from other parts, with Magian-calendar dates, come from Fārs, Zaranj and Airan (Susa?). In only two of the five regions of the Fārs province (2), i.e. Dārābjird and Ardashīr-Khurra, a few coins have come down to us dated by the Magian calendar, whereas the majority of the coins from these regions, as is the case with the other three, are dated by the Yazdgirdī or lunar-Hijrī calendars. Of the 50-odd specimens from different years and cities, struck during the governorship of ʿUbaid-Allāh b. Ziyād, insofar as numismatists have been able to identify them, three bear the Magian-calendar date and seven the Yazdgirdī, all the remainder being dated by the lunar-Hijrī calendar (3). The date of the relevant three is in each case A.20.Y.26 (A.Y.46; A.D. 677/678)(4); the mint names of the first two are Dārābjird and Zaranj, that of the third being uncertain (5). The year A.20.Y.26 is also the earliest date of the Magian calendar to appear on coins of Ardashīr-Khurra and Dārābjird, on which the name of the governor is Salm b. Ziyād (6). According to Walker, the dates on the coins minted at "Airan" are probably by the Magian calendar (7). If "Airan" is synonymous with Susa, as is claimed by Herzfeld and also accepted by Walker (8), this means that the Magian calendar was also employed in Susa. The period covered by the dates on the extant coins clearly shows that the Magian calendar was soon abandoned in most areas, except in Ṭabaristān, where it continued to be used up to A.20.Y.143 (A.Y.163; A.D.794/795)(9). One isolated coin exists from the same province, on which the name of the local governor is al-Faḍl b. Sahl, dated A.20.Y.161 (A.Y.181; A.D.812/13)(10). On the basis of the information gleaned from coinage of the period, together with that from

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1. Paruck (1924), pp.122-128; Walker (1941), pp.130-161; Miles (1950), p.115. For coins of Ṭabaristān bearing dates of the lunar-Hijrī calendar, see also Walker (1956), pp.167-168.

2. For the five provinces of Fārs, see ibn al-Balkhī (1921), pp.121-160; Barthold (1308 H.S.), p.209; Walker (1941), p.cxxxvii.

3. See Walker (1941), pp.xlviii; Miles (1949), p.96.

4. See Walker (1941), pp.xlviii, cxvii, 62-64, 68, 71.

5. Ibid, p.68.

6. Ibid, pp. xlix, cviii, cxvii, 75.

7. Ibid, pp. xlviii, cvii, 52-53.

8. Ibid, p. cvii.

9. Walker (1941), p.160; Miles (1950), p.15.

10. Walker (1941), p.160;. cf. Taqīzādeh (1937), pp.919-920; (1346 H.S.), p.185.

the writings of almost contemporary historians, the Magian calendar would appear to have been in use in Ṭabaristān, Qum, Fārs (two regions only), Sīstān, Khwārazm, Transoxiana and probably Khūzistān (1). There is no evidence of use of this calendar after the third century A.H., apart from references by Bīrūnī and the author of Tārīkh-i Qum and later the colophon of the Pahlavi manuscripts bearing the latest date by the Magian calendar. The latter appears on the colophon of Farvardīn Yasht (K.13) which is dated "day Zamyād (28th)of the month Ābān A.20.Y.1090 (A.Y.1110; 7th May A.D.1741)" (2).

The lack of uniformity in the naming of the Magian and Yazdgirdī calendars in past and present times (see Section IV.I), and the similarity of the two calendars, constitute an obstacle to the identification of dates so expressed, the problem often being insoluble, particularly when the dates are not clearly specified (3). A further difficulty in the identification of dates on coins from the early post-Islamic period is that, although the three different eras, Hijrī, Yazdgirdī and Magian, were in use simultaneously, no identification appears on the coinage. Since the period separating the earliest and latest of the eras is only 31 years, in the case of coins with the name of a governor who held office for more than 31 years identification of the intended era is impossible.

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1. Cf. Taqīzādeh (1937), p.918; (1346 H.S.), p.182.

2. See Geldner (1891-1896), p.iii, xi.

3. Miles (1975), pp.364-365.

IV.III. The Kharājī calendar

As has already been mentioned, the Zoroastrian method of intercalation, i.e. one month of 30 days in a cycle of 120 years, was no longer practised in the post-Islamic period. Consequently, Nawrūz, the great Iranian festival, which was also the starting date of the period in which the land-tax (Kharāj) had to be collected, was not fixed in any particular season (see Section IV.I). The tax-payers, who were generally the landlords (1), and whose payments were based on agricultural produce, were always complaining that the starting date for tax-collection (iftitāḥ-i Kharāj) was before harvest-time (2), which had never been the case during the Sasanian period, when intercalation was in practice (see Section III.II). Bīrūnī (3), quoting Ḥamza of Isfahan and Abū Bakr al-Ṣūlī, states that the problem was first studied by Khālid al-Qasrī, in the reign of Hishām b. ʿAbd al-Malik (A.H.105-125; A.D.724-743), and then, in the reign of Hārūn al-Rashīd, (A.H.170-193; A.D.786-809), by his minister, Yaḥyā b. Khālid al-Barmakī, and later by Mutawakkil (A.H.232-247; A.D.847-861). These rulers and officials made themselves familiar with the Zoroastrian method of intercalation (4) and admitted its relevance to the question of tax-collection as far as the tax-payers were concerned, but none of them was able to do anything about the matter. Khālid al-Qasrī was hindered by Hishām, who maintained that intercalation was forbidden by God (Koran, Sūra IX, 37)(see Section IV.V); when Yaḥyā b. Khālid made plans to postpone Nawrūz for two months at the request of the landlords, his enemies accused him of being "biased in favour of Zoroastrianism", and he did not implement the plan (5). It was during the latter part of Mutawakkil's reign that, according to Bīrūnī, he ordered Ibrāhīm b. ʿAbbās al-Ṣūlī to find out how much time had elapsed since the last intercalation and to draw up proposals for the payment of taxes (6). The court astronomers of Mutawakkil calculated the period from the era of Yazdgird, rather than from the date of the last intercalation. They therefore reached the conclusion that there should be one intercalation of 57 days in the Zoroastrian year to restore Nawrūz to its original location where they believed it had been when intercalation was last practised (7). The new location of Nawrūz is given by various authors as 11th Rabīʿ I, corresponding

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1. Zarrīnkūb (1975), pp.44-45.

2. Bīrūnī (1879), p.36; (1352 H.S.), p.51; Tārīkh-i Qum (1313 H.S.), p.145; see also Muḥīṭ Ṭabāṭabā'ī (1354 H.S.), pp.10 ff.

3. Ibid.

4. Bīrūnī (1879), pp.36-37; (1352 H.S.), p.52.

5. Bīrūnī (1879), p.37; (1352 H.S.), p.52; see als Taqīzādeh (1317 H.S.), p.156.

6. Ibid.

7. Bīrūnī (1879), pp.37-38; (1352 H.S.), pp.52-53.

to 17th Haziran (June)(1), but there is a difference of two years between the year-date given by Bīrūnī (A.H.243)(2) on the one hand and by Ṭabarī (A.H.245) on the other (3). Taqīzādeh claims that, since Ibrāhīm b. al-ʿAbbās al-Ṣūlī, who was charged by the Caliph with the task of studying the question of the intended reform, died in A.H.243, it is difficult to accept the date given by Ṭabarī as that of the original introduction of the reform (4). According to Taqīzādeh, since the year A.H.243 contained no Nawrūz, its re-location could only apply to the Persian New Year falling in A.H.244. This year, which is given by Taqīzādeh, is neither the same as that given by Bīrūnī, nor that given by Ṭabarī and Ibn al-Athīr. There is no evidence to support this date, and Taqīzādeh admits that it is his own personal assumption (5). Moreover, we find that Taqīzādeh gives different dates for the same operation in various works, and even in one and the same article (6). It seems that Taqīzādeh, who on several occasions refers to Bīrūnī's report that "Mutawakkil was killed and his plan was not carried out"(7), must have overlooked this fact when attempting to discover the date of an operation which had never, in fact, been performed. Quite apart from Bīrūnī's report, and a similar report contained in an extract of Nawrūz-nāma (8), where the author states that "Mutawakkil rejected the postponement of Nawrūz, despite his minister's insistence" (see above, p.101, n.8), there is evidence of consistent complaints from tax-payers, during the period following the assassination of Mutawakkil, claiming that the starting date for tax-collection (Nawrūz) was too early and pleading for an intercalation. According to the author of Tarīkh-i Qum, during the time of Muʿtamid (A.H.256-279; A.D.870-892), the people expressed the same complaint about the progressively earlier, and thereby unseasonable, date of tax-collection (9).

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1. See Humā'ī (1340 H.S.), pp.373-374, n.2, 395-397; Mīnovī (1312 H.S.), p.88; cf. Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), p.685.

2. Bīrūnī (1879), p.37; (1352 H.S.), p.52; cf. Bihrūz (1331 H.S.), pp.66-69.

3. Ṭabarī (1352-1354 H.S.), p.6069.

4. Taqīzādeh (1937), p.909; (1346), p.169. The date of Ibrāhīm b.ʿAbbās' death is given by Ṭabarī ((1352-1354 H.S.), p.6059) as Shaʿbān 243 A.H.

5. Taqīzādeh (1937), p.908; (1346 H.S.), p.169.

6. Taqīzādeh (1317 H.S.), pp.156-157; (1940-1942), p.131; (1346 H.S.), p.226; (1349 H.S.), pp.191-195.

7. Taqīzadeh (1317 H.S.), pp.156-157; (1940-1942), p.131; (1946 H.S.), p.226.

8. Rieu, (Add. 23,565), fol.89^{b}.

9. Tārīkh-i Qum (1313 H.S.), pp.145-146; see also Masʿūdī (1347 H.S.), p.664; Mīnovī (1312 H.S.), p.88; Spuler (1952), p.483.

It was finally Mu'tadid (A.H.279-289; A.D.892-902) who organized an intercalation of two months in the Zoroastrian year in response to these complaints. In attempting to calculate the period during which intercalation had not been implemented, Mu'tadid's court astronomers, who calculated from the Magian era, were guilty of the same mistake as that committed in Mutawakkil's time (1). It seems that this mistake, which was repeated by many historians and astronomers in later centuries, arose from a misunderstanding of Zoroastrian intercalation, as explained by Zoroastrian priests, astronomers and historians of the early Islamic period. The Zoroastrian priest, who was summoned before Mutawakkil, in replying to the Caliph's question about Zoroastrian intercalation and the progressively earlier, and therefore unseasonable, date of Nawrūz, stated that "the Iranians used to intercalate the years, but when Islam appeared and destroyed our Kingdom and religion, the intercalation was also abandoned"(2). This, and other similar statements were erroneously interpreted as implying that the last intercalation was at the time of Yazdgird III, the last Sasanian monarch (see Chapter III). It would appear that such a misunderstanding was the reason why the court astronomers of Mu'tadid chose 11th Haziran (June), which was the same month of the epoch of the Magian era, as the new location of Nawrūz in their attempt to bring it back to its original location. The equivalent dates of Mu'tadid's relocation of Nawrūz, given by several historians and astronomers by different calendar systems as Wednesday 1st Khurdād A.Y.264 (13th Rabī' II A.H.282; 11th Haziran)(3), indicate that the intercalation of two months in this year was the first and only reform in the method of time-reckoning used for tax-collection purposes up to A.H.282 (A.D.895). Mu'tadid adopted the Julian method of intercalation to stabilize Nawrūz in relation to astronomical points: whenever the Julian-calendar year was 366 days, an additional day was added to the five supplementary days at the end of the eighth month (Ābān)(4). Although there can be no doubt that the calendar by which taxes were collected was identical to the official calendar of the Sasanian period, the location of the five supplementary days at the end of Ābān in the calendar in which the intercalation was performed by Mu'tadid is also identical in both the official and the religious Sasanian calendars (5).

Taqīzādeh is of the opinion that the method of time-reckoning employed for tax-collection purposes during the early-Islamic period was a lunar method (6). According to Taqīzādeh, the method of keeping the lunar calendar, which was then the official calendar used

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1. Bīrūnī (1879), p.38; (1352 H.S.), p.54.

2. See Bickerman (1967), p.203; Boyce (1970), p.528.

3. Ṭabarī (1352-1354 H.S.), pp.6658-6659, 6673; Mas'ūdī (1347 H.S.), p.664; Ḥamza (1346 H.S.), p.3; Bīrūnī (1934), p.186; (1316-1318 H.S.), p.271; (1879), p.258; (1352 H.S.), p.358.

4. Bīrūnī (1879), p.81; (1352 H.S.), p.103.

5. Ibid.

6. Taqīzādeh (1937), pp.905-909, 910; (1346 H.S.), pp.164-170, 171.

for both secular and religious purposes, in phase with what he describes as the "solar year" used for tax-collection purposes, was to omit one lunar year every 33 or 34 lunar years (1). No mention of the use of such a method in the early Islamic period is made by Bīrūnī or by any previous trustworthy post-Islamic historian or astronomer in their references to time-reckoning. According to Taqīzādeh, the author of Zīj-i Ashrafī (compiled in A.H.702; A.D.1302/3) and Sharaf al-Dīn ʿAlī Yazdī (A.H.828; A.D.1424) both place the institution of the Kharājī calendar in the latter part of the Sasanian period, but Taqīzādeh himself considers this to be on the early side (2). Taqīzādeh's objection is based on his belief that, since there was no lunar year in use in the Sasanian administrative departments, there was no need for a double system. Such an argument arises from a misunderstanding of the Kharājī calendar on the one hand and the time-reckoning of the latter part of the Sasanian period on the other. As has already been mentioned (see Section II.III), two different calendars were in use during the latter part of the Sasanian period: the religious (Vahījakīk), and the official (Kharājī), the latter also being used for tax-collection and subsequently adopted by the Arabs for the same purpose (3). It would appear that when Ḥajjāj b. Yūsuf, the tyrannical Umayyad governor of Iraq, decreed a change in the language of the tax-collection records (dīwān) from Persian to Arabic (4), the method of time-reckoning, which was also Iranian (Zoroastrian), remained unchanged. The author of Zīj-i Ashrafī, whose main reason for dealing with the Kharājī calendar was because it was well-known among the people and astronomers, states that the people and astronomers believed that the adoption of this calendar goes back to the time of ʿUmar b. al-Khaṭṭāb, the second caliph (5).

Taqīzādeh also disagrees with the date given by Mukhtār Pāshā and Ginzel for the institution of the Kharājī calendar during the reign of the Caliph al-Ṭā'iʿ (A.H.363-381; A.D.974-991): he refers to a financial document from an earlier period, reproduced in Tārīkh-i Qum, and states that the solar year with the name of Kharājī (by which he means the period of 33 or 34 lunar years with a one-year omission, the institution of which Ginzel attributes to al-Ṭā'iʿ) must have been in use in the early centuries of Islam and perhaps as early as the establishment of Arabian rule in Iraq and Iran (6). No actual Kharājī date

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1. Taqīzādeh (1937), pp.905-907; (1346 H.S.), pp.164-166.

2. Taqīzādeh (1937), p.907; (1346 H.S.), p.166.

3. Spuler (1952), p.441; Bahār (1321 H.S.I), pp.227-228; see also Dodge (1970), p.581, n.37.

4. Ibn Nadīm (1970), pp.581-583; Humā'ī (1340 H.S.), pp.156, 356-361; Zarrīnkūb (1343 H.S.), p.446; Bahār (1321 H.S.I), p.228.

5. Zīj-i Ashrafī (Paris 1488), folios, 3^a-3^b.

6. Taqīzādeh (1937), p.907; (1346 H.S.), p.166; see also Ginzel (1906), p.295; Vollers (1910), p.127. Cf. Taqīzādeh (1317 H.S.), p.162.

is given in this document: there is merely a mention of "li-hādhā'l-Sanat al-Kharājīya" (in this Kharājī year) (1). In the light of the references in the Tārīkh-i Qum to the Kharājī months during which taxes were paid (generally nine or ten, but occasionally eleven or twelve Zoroastrian months), it is probable that the Kharājī year should be interpreted as a taxation-period, and that the calendar used was simply the Zoroastrian year (without intercalation, as the author of Tārīkh-i Qum states)(2). Taqīzādeh himself, in his account of the Mu'tadidī calendar in the second part of the same article, explicitly states that Mu'tadīd's postponement of the Iranian Nawrūz was for the benefit of tax-payers and clearly indicates that the method of time-reckoning used in tax-collection was none other than the Zoroastrian calendar (3). Taqīzādeh maintains that the Mu'tadidī calendar, with the Julian method of intercalation, was in use for a long time and perhaps up to the establishment of the Jalālī calendar. He also states that the times due for the omission of one lunar year coincided with the time-in-office of Mutawakkil and Mu'tadid and that they omitted the year as planned (4). There is unfortunately no evidence in existence to support the latter assertion.

Although only a few pre-Mongol authors give dates in accordance with a calendar which they call Kharājī, sometimes accompanied by equivalent dates usually in accordance with the lunar-Hijrī calendar, these are quantitatively adequate to permit determination of the essential features of the Kharājī calendar. This produces results differing considerably from those arrived at by Taqīzādeh. A list of such Kharājī dates, accompanied by their equivalents in other calendars, appears in Table 11.

The era of the Kharājī calendar is given by Muḥammad b. Abī 'Abd-Allāh Sanjar al-Kamālī, the author of Zīj-i Ashrafī, as 468 solar years before the Jalālī era (5). Counting back 468 years of 365 days from the Jalālī era (15th March A.D.1079; 9th Ramaḍān A.H.471; 1st Farvardīn H.S.458), the Kharājī era would fall in A.D.611, which is the 21st year of the reign of Khusraw II. This date (A.D.611) is corroborated by a report given by the same author, in which the Kharājī era is given as 170,933 days before the Jalālī era, or as 3714 years and 234 days (1,355,844 days) after the era of Ṭūfān (Deluge)(6). The king during whose reign the era of the Kharājī

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1. Tārīkh-i Qum (1313 H.S.), pp.149-153.

2. Ibid, p.144.

3. Taqīzādeh (1940-1942), p.131; (1346 H.S.), pp.225-226.

4. Taqīzādeh (1937), p.910; (1346 H.S.), p.171; cf. Taqīzādeh (1317 H.S.), p.159.

5. Zīj-i Ashrafī (Paris 1488), fol.10^{b}.

6. Ibid, folios 3^{b}, 10^{a-b}.

calendar is located is again named as Khusraw Parviz (Khusraw II, A.D.590-628)(1), the era being 7765 days before the Yazdgirdī era, or 4136 days before the Hijrī era, i.e. the 21st year of the reign of Khusraw II (2). This latter year is the earliest date to figure on standard Arab-Sasanian Khusraw-II coins, which were struck during the post-Islamic period up to A.H.74 (3); this fact may have some connection with the Kharājī era, which is also the 21st year of the reign of Khusraw II. This correspondence, which can also be confirmed mathematically (4), implies that the Kharājī era cannot be other than the 21st year of the reign of Khusraw II, and that notwithstanding Taqīzādeh's claim to the contrary, it has nothing to do with the Hijrī era.

The same year 468 for the era of the Jalālī calendar is also given by Ulugh Beg and other astronomers and historians, but they incorrectly qualify it with the word Hijrī and even give the Arabian month-name alongside the date. However, since the era of the Jalālī calendar is undoubtedly during A.H.471 and not in A.H.468, the year 468 which these authors have in mind must be 468 Kharājī, reckoned from A.D.611 (see Section IV.IV).

The list of Kharājī dates in Table 11 clearly shows that, although they are all qualified by the epithet Kharājī in the sources, they are not all of the same nature. The interval between the last two Kharājī dates in Table 11 (Nos. 15, 16), reckoning from 1st Farvardīn 692 Kharājī to 13th Khurdād 693 Kharājī, is 438 days, whereas the interval between their two equivalent lunar-Hijrī dates given in the same sources is 365 days. Unless the authors who gave these dates made a mistake, which they do not appear to have done, this means that the month-date of the year 692 Kharājī (1st Farvardīn) corresponds to the same month in the Jalālī calendar given in column 4 of the table. This is in agreement with the report given by the author of Zīj-i Mumtaḥan, according to which the months of the Kharājī calendar are the same as the Iranian months, and the beginning of the Kharājī year is at the sun's entry into Aries (5). The month-day of the Kharājī and Jalālī-calendar dates corresponding to 1st Farvardīn 693, as given by the author of Zīj-i Ashrafī (6), indicates that the two

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1. Zīj-i Ashrafī (Paris 1488), fol.3^{b}.

2. Zīj-i Ashrafī (Paris 1488), fol.10^{a}; see also Zīj-i Mumtaḥan (Gg.3.27), fol.7^{b}.

3. Walker (1941), p.xxvi; see also Zarrīnkūb (1341 H.S.), p.91.

4. The author of Zīj-i Ashrafī not only gives the intervals between the Kharājī era and the era of Ṭūfān, the Seleucid era, the Hijrī era and the Jalālī era, but mathematically proves the location of the Kharājī era to be in the reign of Khusraw II. See Zīj-i Ashrafī (Paris 1488), folios 10^{b}-11^{b}.

5. Zīj-i Mumtaḥan (Gg.3.27), fol.5^{b}.

6. Zīj-i Ashrafī (Paris 1488), fol.10^{b}.

calendars were then exactly in parallel, apart from the fact that their eras were separated by 468 years. The author of Zīj-i Mumtaḥan states that each of the Kharājī months is of 30 days, and the epagomenae are located at the end of the twelfth month (Isfandārmadh)(1); this also applies to the Jalālī calendar. Although, according to this author, every fourth year of the Kharājī calendar was a leap year of 366 days, the coincidence of the beginning of the Kharājī and Jalālī calendars for the years 692 and 693 Kharājī indicates that both calendars followed the same intercalation-rules. This means that the Kharājī dates given by Waṣṣāf, and likewise date No. 15 in Table 11, are Kharājī dates of the above-mentioned type and are thus different from those given by the author of Zīj-i Ashrafī (No. 16).

The Yazdgirdī month-date corresponding to date No. 16 in Table 11 appears in column 5 as 13th Khurdād, which is equivalent to 1st Farvardīn Jalālī, assuming that the month and month-day are of Yazdgirdī origin; the interval between date No. 15 and date No. 16 will be 365 days and must be identical to that between the two corresponding Hijrī dates. This means that the Kharājī calendar, which according to the author of Zīj-i Ashrafī was used in Fārs, must have been identical to the Yazdgirdī calendar, except in respect of its era, which was in the 21st year of the reign of Khusraw II. This calendar must have been the original Kharājī calendar in use from the very early post-Islamic period, whereas the later Kharājī calendar came into existence as a result of the establishment of the Jalālī calendar.

Although there can be no doubt about the existence of the two different Kharājī calendars, there are still difficulties over the dates obtained from the Saljūq-nāma of Muḥammad Ibrāhim, which constitute the majority of the dates in Table 11. The exact nature of the calendar used by this author is not known, and the equivalent dates in other calendars calculated from the equivalent lunar dates given by him indicate that most of these dates are incorrect. Insofar as it is possible to determine the fundamental features of the calendar used in the Saljūq-nāma from the mathematical relationship between the dates, it is certain that the era by which the dates are given is the same as the era of the other Kharājī dates given in Table 11, namely the 21st year of Khusraw II (A.D.611); but since the dates appear to be incorrect, the exact nature of this calendar cannot be determined. The hypothesis, advanced by Taqīzādeh, of an arbitrary omission of one lunar year whenever the dates were not in harmony with their equivalent Hijrī dates, is not supported by available evidence for the early post-Islamic period. A similar method was used in Iran in the post-Mongol period, which will be discussed in Section IV.V.

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1. Zij-i Mumtahan (Gg.3.27), folios 5^{b}-6^{a-b}.

IV.IV. The Jalālī calendar

The calendar named after Sulṭān Jalāl al-Dawla Mu'izz al-Dīn Abu'l-Fatḥ Malik-Shāh-i Saljūqī and variously designated "Tārīkh-i Jalālī", "Tārīkh-i Malikī", "Tārīkh-i Malikshāhī", "Tārīkh-i Sulṭānī" and "Tārīkh-i Muḥdath" (newly-instituted)(1), was established during the reign of this Saljūq monarch (A.H.465-485; A.D.1072-1092). Several different methods can be used for reliable determination of the dates in other calendars corresponding to the epoch of the Jalālī era, i.e. 1st Farvardīn of the first year of the Jalālī calendar, for which the Julian, lunar-Hijrī and solar-Hijrī equivalents have been given by many authors, not all of which are in agreement.

The most reliable method is by retrogressive calculation from a Jalālī date given alongside its equivalent "other-calendar" date in literary sources, using chronological formulae provided by Naṣīr al-Dīn Ṭūsī (2), Ulugh Beg (3) and other authors (4) for the conversion of Jalālī dates to Yazdgirdī, lunar-Hijrī and Seleucid dates (see Chapter V). Another method is to reckon the intervals between the epoch of the Jalālī era and the epoch of several other well-known eras, derived from numerous more or less contemporary authors. The generally accepted intervals are:

Epoch of Iskandar (Seleucid era)	507,497 days
Epoch of Christian era	393,813 days
Epoch of Kharājī era	170,933 days
Epoch of Hijrī era	166,797 days
Epoch of Yazdgirdī era	163,173 days

The above figures, apart from that relating to the Christian era which appears (commonly with an error of one day) in certain comparatively recent works (5), are given in Zīj-i Ilkhānī (6)

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1. See Zīj-i Ilkhānī (O.2(7)), folios 3^b, 15^b; al-Simnānī (Add. 11,636), fol. 5^b; Zīj-i Ulugh Beg (1847), p.309; Bīrjandī (Ethe 3000), fol.17^b; Mullā Muẓaffar (1267 A.H.), Bab. 2nd, 4; Muntakhab-i Ḥall-i Taqwīm (Ethe 2248), folios 11^{a-b}.

2. Zīj-i Ilkhānī (O.2(7)), folios 15^b-16^a.

3. Ulugh Beg (1837), pp.310-312. Ulugh Beg's formula is also reproduced by Ideler ((1826), pp.532-533) and Ginzel ((1906), pp. 302-303).

4. Bīrjandī (Ethe 2237), folios 24^b-26^b.

5. See Ideler (1826), p.533.

6. Zīj-i Ilkhānī (O.2(7)), fol.14^b; (Add.7698), fol.16^b.

and Zīj-i Ulugh Beg (1), and in all later annotated versions of these two works (2). Identical figures appear in the introduction to several astronomical tables of later centuries (3), probably taken by their authors directly from the above sources.

The day-interval between the epoch of the Kharājī and the epoch of the Jalālī eras is given by the author of Zīj-i Mumtaḥan (4) and the author of Zīj-i Ashrafī (5). This figure is important not only for the determination of the epoch of the Jalālī era, but for determination of the epoch of the era of the Kharājī calendar (see Section IV.III).

The equivalent Hijrī date of the epoch of the Jalālī calendar, using the above-mentioned method of calculation, is Jum'a (Friday), 9th Ramaḍān A.H.471 (15th March A.D.1079; 19th Farvardīn A.Y.448), which corresponds to the date given by most authoritative authors. On the other hand, according to Taqīzādeh, "As to the Arabian date (lunar-Hijrī), though all reports agree in that it was a Friday, some of our sources give it as 10 Ramaḍān and some others as the ninth day of the same month. But none of these dates agree with the said day of the week (Friday)"(6). Taqīzādeh's argument is based on Schram's zodiac tables, which Ginzel also used for the same purpose (7); although Taqīzādeh does not explicitly refer to Ginzel, his own conclusion would appear to represent a misinterpretation of the conclusion by that author half a century earlier. In spite of Taqīzādeh's claim, a casual inspection of various perpetual calendars available in most Iranian books of astronomical tables compiled near that time, or of any modern handbook of Iranian dates, will show that 9th Ramaḍān A.H.471 was in fact a Friday (8). It is even possible that the same

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1. Zīj-i Ulugh Beg (1847), p.312.

2. Al-Simmānī (Add.11,636), fol.56; Bīrjandī (Ethe 2237), folios 25^{a}-26^{b}; (Ethe 3000), folios 19^{b}-20^{a}; (Add.23,567), folios 22^{a}-23^{a}.

3. Zīj-i Shāhjahānī (or. 372), fol.8^{a}; Risāla-yi Sī-faṣl (Ethe 2254), annotation to faṣl 3rd; Historical tables (Ethe 2730), fol.76.

4. Zīj-i Mumtaḥan (Gg.3.27), fol.5^{b}.

5. Zīj-i Ashrafī (Paris 1488), folios 10^{a-b}.

6. Taqīzādeh (1940-1942), p.112; (1346 H.S.), pp.197-198.

7. Ginzel (1906), pp.303-304. The corresponding Julian, lunar-Hijrī and Yazdgirdī calendar-dates of the epoch of the Jalālī era are given by Ginzel (p.300): 15th March 1079, Friday 10th Ramaḍān A.H.471 and 19th Farvardīn A.Y.448, respectively. See also Ideler (1826), pp.526 ff., where the same dates are given for the epoch of the Jalālī era.

8. See Rīyāḥī (1335 H.S.), p.14; Abdollahy (1352 H.S.), pp.734-739; also Chapter V of present work.

Friday was reckoned as 8th, 9th or 10th Ramaḍān of the same year by different people in Malik-Shāh's extensive domain. It was the common practice amongst the Moslems of that time (and still is now) for the beginning and end of Ramaḍān to be proclaimed by the Muftī on the basis of reports of direct observation of the new moon by reliable persons (1). On one occasion, when Malik-Shāh issued an order proclaiming the end of Ramaḍān, the Muftī (a certain Abū'l Mu'allā) ignored the King's command (2). While those who observed the new moon personally regarded that day as the first of Shawwāl (tenth Arabian month), those who were still awaiting the Muftī's announcement looked upon the same day as the 30th day of Ramaḍān (ninth and fasting month).

The year-date of the era of the Jalālī calendar has also been a matter of uncertainty, because different years are given in the sources, many of which have undoubtedly been subject to mis-copying or to mistakes or misunderstandings on the part of the authors. For example, the year given by the author of Tārīkh-i Banākatī is A.H.417 (3), which, since Malik-Shāh had not then been born, cannot be correct and is probably a transposition of 471. On several occasions, Bulsarsa gives the date of the reform of the calendar "under the direction of the Saljūq sovereign Malik-Shāh"(4) as A.D.1099 (5). Bearing in mind that Malik-Shāh died in A.D.1092 (6), Bulsara's date likewise cannot be correct. It will, however, be shown below that there is no doubt whatever as to the first year or even the first day of the Jalālī calendar, which, as has already been mentioned, coincides with 9th Ramaḍān A.H.471 (15th March A.D.1079; 19th Farvardīn A.Y.448). Admittedly, Ulugh Beg (7), in his astronomical tables (so-called "Zīj-i Ulugh Beg", "Zīj-i Sulṭānī", "Zīj-i Khāqānī", "Zīj-i Gūrkānī")(8), Bīrjandī in his commentary on the same work (9), and many other authors,

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1. Sayili (1960), pp.27-28.

2. Ibid, p.28.

3. Tārīkh-i Banākatī (1348 H.S.), p.26. The two British Museum MSS. of Tārīkh-i Banākatī ((Add.7626), fol.12^{a} and (Add.7627), fol.10^{b}) both bear the date 417.

4. Bulsara (1953), p.190.

5. Ibid, p.187, n.1, pp.190-192.

6. See Bosworth (1968), pp.66 ff.

7. Zīj-i Ulugh Beg (1847), pp.309-310; cf. Barani (1943), p.170.

8. See the colophon of Zīj-i Jadīd-i Sulṭānī (Ethe 2233); Zīj-i Khāqānī (Ethe 2232); Barthold (1958,I), pp.130-131; Kennedy (1956), pp.125-126.

9. See Bīrjandī (Ethe 2237), fol.23^{a}.

probably using these two sources (1), give the year-date of the Jalālī era either as A.H.468 or 471; however, since Ulugh Beg could find no evidence that the era of the Jalālī calendar was in A.H.468, he preferred the year 471, which he claimed to be more-widely accepted. The same opinion is expressed by many other authors: d'Herbelot (2), for example, in his "Bibliothèque Orientale", gives the same two dates, accompanied by the claim that European orientalists had generally accepted A.H.471. The eminent Iranian scholar Jalāl al-Dīn Humā'ī, after collating reports by earlier astronomers and historians, has reached the considered conclusion that the question cannot be settled without further evidence (3).

At first sight, the report given by Ibn al-Athīr (4) does not agree either with A.H.471, which is the true era, or with the year A.H.468 also given by Ulugh Beg. Speaking of the year A.H.467 (A.D. 1074/75) Ibn al-Athīr states that "In this year Niẓām al-Mulk and Sulṭān Malik-Shāh gathered together a group of distinguished astronomers to stabilize Nawrūz at the beginning of Aries, whereas previously Nawrūz had coincided with the sun's entry into the middle of Pisces. The King's achievement became the era of calendars. Likewise, in this year the observatory was built for Sulṭān Malik-Shāh, and a group of outstanding astronomers came together for its foundation, among whom were 'Umar b. Ibrāhīm al-Khayyāmī, Abu' l-Muẓaffar al-Isfizārī and Maymūn b. Najīb al-Wāsiṭī and others"(5). Since the same year is also given by Khāzinī (6), a contemporary astronomer (7), as "the year of the issue of the royal order"(8), Ibn al-Athīr would

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1. See Humā'ī (1340 H.S.), p.442, n.1; Taqīzādeh (1940-1942), pp.108 ff.; (1346 H.S.), pp.192 ff.

2. d'Herbelot (1776), p.834; see also Ginzel (1906), p.300.

3. Humā'ī (1940 H.S.), p.442, n.1; (1316-1318 H.S.), pp.239-240, n.12; cf. Mīnovī (1312 H.S.), p.89.

4. See Qazwīnī (1910), pp.214, 228; Brown (1921), p.71, n.3; Ṣafā (1336 H.S., II), pp.311-315; Sayili (1960), p.161; Companyuni (1336 H.S.), p.167, n.1.

5. Other astronomers, who are said to have been involved in the calendar reform are: Abd al-Raḥmān Khāzinī, Muḥammad b. Aḥmad al-Ma'mūrī al-Bayhaqī, Ḥakīm Abu'l-'Abbās Faḍl b. Muḥammad al-Lukarī; see Bīrjandī (Ethe 3000), fol.17^{b}; Mullā Muẓaffar (1267 A.H.), Bab 2nd, 4; Rabī' al-Munajjimīn (Sepahsālar 661), Faṣl, 6th; Mīnovī (1312 H.S.), p.89; Humā'ī (1316-1318 H.S.), pp.239-240, n.12; Sayili (1960), pp.161, 164-165; Companyuni (1336 H.S.), pp.166 ff.

6. Taqīzādeh (1940-42), p.111; (1346 H.S.), p.196.

7. See Muḥīt Ṭabāṭabā'ī (1352 H.S.), pp.683-692; Companyuni (1336 H.S.), pp,173, 176-177; Kennedy (1968), p.672.

8. See Taqīzādeh (1940-1942), p.111; (1346 H.S.), p.196.

appear to mean the start of work on the reform of the calendar (1); he listed all the relevant activities which were going on, some of which were not finished, according to the authors of Nawrūz-nāma (2), until after the death of Malik-Shāh.

Taking A.H.467 as the year of issue of the royal order and A.H. 471 as the era of the Jalālī calendar, Taqīzādeh has proposed a solution for the problem of the year 468, which Ulugh Beg also gives for the era of the Jalālī calendar. Taqīzādeh is of the opinion that it was in A.H.467 that Malik-Shāh invited the astronomers (3) and recommended a reform whereby Nawrūz might be celebrated in the spring (4), but that this order must have been carried-out in the following year, i.e. 468 (5), which agrees with Ulugh Beg's statement (6); that the astronomers' advice to the King to institute an era bearing his name was given later, and the year A.H.471 was chosen as the beginning of the new era (7).

This elegant solution, however, although accepted by modern historians (8), disagrees with the relevant reports given by the mediaeval authorities on the question.

Naṣīr al-Dīn Ṭūsī, one of the most-reliable authorities on the Jalālī calendar, states that "the era of this calendar came after Kabīsa-yi Malik-Shāhī' (Malik-Shāh's intercalation)" (9). This statement, repeated by Mullā Muẓaffar (10) and many astronomers and

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1. Ideler (1826), p.529; Mīnovī (1312 H.S.), p.89.

2. Nawrūz-nāma (1312 H.S.), p.12; (Add.23,565), fol.89^{a-b}.

3. Taqīzādeh (1940-1942), pp.111-112; (1346 H.S.), p.197.

4. Taqīzādeh (1940-1942), p.112; (1346 H.S.), p.197.

5. Taqīzādeh (1940-1942), p.112; (1346 H.S.), p.197. In identical passages, Ideler ((1826), p.529) and Ginzel ((1906), pp.300-301) state that "Observation by the astronomer commission to determine the vernal equinox probably began a few years before A.H.471, since accurate determination of the equinox was still a difficult task for the astronomers of that time, and they could not be certain to within a day; it was not until later that they decided on the year A.H.471".

6. Taqīzadeh (1940-1942), p.111; (1346 H.S.), p.196.

7. Taqīzadeh (1940-1942), pp.111-112; (1346 H.S.), p.197.

8. Sayili (1960), p.161.

9. Sī-faṣl (1330 A.H.), Faṣl, 6th. See also commentary to same work (Add.7700), fol.12^{b}; Humā'ī (1340 H.S.), pp.442-443.

10. Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 4; (Ethe 2247), fol.13^{a}.

historians, clearly indicates that the first Nawrūz which was shifted from the middle of Pisces to the first degree of Aries is the epoch of the era of the Jalālī calendar. It would nevertheless be unreasonable to suppose that it was in the year 468 that Nawrūz was first moved to its new location and that, after a lapse of several years, the year A.H.471 (A.D.1079; A.Y.448) was then chosen as the era of the calendar. Almost all post-Islamic Iranian authors define the era of time-reckoning as a definite year in which an outstanding event occurred (1). The only outstanding feature of the year A.H.471 (A.Y. 448), which was chosen as the era of the calendar, was the shifting of Nawrūz to its new location (2).

Abū Ja'far Muḥammad b. Ayyūb al-Ḥāsib al-Ṭabarī, a contemporary astronomer, who compiled his Zīj in A.Y.455, seven years after the Jalālī era (3), gives the corresponding Yazdgirdī date of the first day of the first year on which Nawrūz was shifted as the first day of A.Y.447 (25th February 1078; 9th Sha'bān A.H.470)(4). Since the first days of the Yazdgirdī and Jalālī-calendar years have never fallen in the same year from the establishment of the Jalālī calendar up to the present day, the date given by this author cannot be correct.

Although it is certain that the date given by Abū Ja'far Ṭabarī is incorrect (5), there would in any case be a difference of two years between this date and the date A.H.468 given by Ulugh Beg.

A solution was proposed comparatively recently by Muḥīṭ Ṭabāṭabā'ī, who believes that Khāzinī was the first (in A.H.468) to discover a scientific rule for intercalation in the Iranian calendar, and that the commission of calendar reform appointed by Malik-Shāh tried to discredit Khāzinī's discovery, and three years later than Khāzinī's discovery established an era named after Malik-Shāh. Ṭabāṭabā'ī is of the opinion that, two centuries later, Naṣīr al-Dīn Ṭūsī was still trying to discredit Khāzinī's discovery. Ṭabāṭabā'ī quotes many sources, but none of them indicates that Khāzinī was the inventor of Kabīsa-yi Jalālī (6).

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1. See Bīrūnī (1879), p.16; (1352 H.S.), p.23; (1934), p.171; (1316-1318 H.S.), pp.235-236; also Bīrjandī (Ethe 2237), fol.8^b; Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 2.

2. Sharḥ-i Sī-faṣl (Add.7700), fol.12^a; Mullā Muẓaffar (1267 A.H.), Bāb 4th.

3. See Brown's hand-written annotations on the colophon of Zīj-i Mufrad (O.1.(10)); also Taqīzādeh (1940-1942), pp.112-113; (1346 H.S.), p.198; Kennedy (1956), p.134.

4. Zīj-i Mufrad (O.1.(10)), fol.19^b.

5. Taqīzādeh (1940-1942), pp.112-113; (1346 H.S.), p.198.

6. Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), pp.683-692; see also Rūz-nāma-yi Iṭṭilā'āt, No. 14080, Monday, 3rd Urd., 1352 H.S.

The most probable theory would appear to be that of Taqīzādeh, who (in a foot-note) surmises a possible error on the part of Ulugh Beg (1). Taqīzādeh's opinion is that the year 468 is the Kharājī date corresponding to A.H.471. According to Taqīzādeh, Ulugh Beg probably discovered the two dates in an unqualified form, one (471) representing the Hilālī (lunar), and the other the Kharājī date for the same year, and took the two dates as different lunar years 468, (the month and day not being given in Ulugh Beg's source), appending the suffix "5th Sha'bān" to the year (2). At the time when Taqīzādeh was making such statements, the precise nature of the Kharājī calendar was still unclear (see Section IV.III); even Taqīzādeh had refused to accept the validity of the sources Zīj-i Ashrafī and Ẓafarnāma, both of which indicate that the Kharājī calendar was not reckoned from the Hijrī era (see Section IV.III). It is now clear that the only calendar by which the epoch of the Jalālī calendar can be dated as 468 is the Kharājī calendar (see Section IV.III). There is consequently an exact correlation between 19th Farvardīn 468 Kharājī and 19th Farvardīn A.Y.448, which was taken by Malik-Shāh's "calendar-reform committee" as 1st Farvardīn, coinciding with the sun's entry into Aries. Most astronomers and historians agree that the first 18 days of Farvardīn of the Yazdgirdī year in which the epoch of the Jalālī era fell were subsequently regarded as belonging to the preceding year (A.Y.447)(3), with the implication that the year A.Y.447 consisted of 383 days, the extra 18 days being referred to as "Kabīsa-yi Jalālī" or "Kabīsa-yi Malik-Shāhī"(4). In order to distinguish the months of the two calendars, in which the same Zoroastrian month-names were used (5), the months of the Yazdgirdī calendar were qualified by the suffix "qadīmī" and those of the Jalālī calendar by either "Jalālī"(6) or "Malikī"(7).

The mediaeval astronomers report that, since the year-length of the Jalālī calendar is absolutely tropical (true solar year), the length of its months was taken by some to be that of a true solar month (8):

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1. Taqīzādeh (1940-1942), p.111, n.2; (1346 H.S.), p.196, n.3.

2. Taqīzādeh (1940-1942), p.111, n.2; (1346 H.S.), p.196, n.3. Cf. Barani (1943), pp.169 ff.

3. Bīrjandī (Ethe 2237), fol.23^{b}; Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 4.

4. Naṣīr al-Dīn Ṭūsī (1330 A.H.), faṣl 6th.

5. Naṣīr al-Dīn Ṭūsī (O.2.(7)), fol.15^{b}; (1330 A.H.), faṣl 6th; Bīrjandī (Ethe 2237), fol.23^{b}; Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 4.

6. Bīrjandī (Ethe 2237), fol.24^{b}; Qūshchī (1330 A.H.), Bāb 9th.

7. Mullā Muẓaffar (1267 A.H.), Bab 2nd, 4.

8. Naṣīr al-Dīn Ṭūsī (O.2.(7)), fol.15^{b}; Ulugh Beg (1847), p.310; Bīrjandī (Ethe 2237), fol.23^{b}. Sharḥ-i Sī-faṣl (Add.7700), fol.11^{a}.

to such people, the beginning of each month was the day on which the sun entered the sign of the zodiac assocated with that month (1)(see Section I.II.). The seasons in this calendar were thus astronomically true, the beginning of each season being marked by the "apparent passage of the sun" through the equinoctial and solstitial points (2). The evidence of Ulugh Beg, Qutb al-Dīn Shīrāzī and many others leaves little doubt that the true solar month was in fact used in the Jalālī calendar (3), despite the non-existence of earlier documents to corroborate this conclusion. It seems that the true solar month of the Jalālī calendar never became as popular as the conventional 30-day month. The five supplementary days were transferred from the end of Abān (eighth month), where they had been located since A.D.461 (see Section III.II), to the end of Isfand-Māh-i Jalālī (twelfth month)(4), where they remained, and where they even today may be encountered in certain Iranian almanacs.

Naṣīr al-Dīn Ṭūsī, whose description of the Jalālī calendar in his work Zīj-i Ilkhānī (5) is in agreement with the above, states elsewhere that certain astronomers had earlier recorded the introduction of new month-names and day-names for the Jalālī calendar (6). The names given by Naṣīr al-Dīn, for which there are no extant datings, are also shown in Zīj-i Ashrafī alongside their sequence numbers, which are given in the Abjad (or Abājad or Abū-jad) alphabet (7). Because of inadequate attention by copyists of original sources, the names appear in certain works in a sequence which is without doubt incorrect (8). The correct sequences of the month-names and day-names are shown in Tables 12 and 13, respectively.

The main aim of the calendar-reform was neither to shift the five supplementary days, nor to introduce true solar months, which would be difficult to determine and would thereby make time-reckoning more complicated (see Section I.II): rather was it to establish the beginning

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1. Bīrjandī (Ethe 2237), fol.23^{b}; Sharḥ-i Sī-faṣl (Add.7700), fol.12^{a}.

2. Sharḥ-i Sī-faṣl (Add.7700), folios 12^{a}-12^{b}; see also Humā'ī (1340 H.S.), p.442.

3. Ulugh Beg (1847), p.310; Taqīzādeh (1940-1942), p.117; (1346 H.S.), p.205.

4. Zīj-i Ilkhānī (O.2.(7)), fol.15^{b}; al-Simnānī (Add.11,636), fol.4^{b}; Bīrjandī (Ethe 3000), fol.18^{a}.

5. Zīj-i Ilkhānī (O.2.(7)), fol.15^{b}; (Add.7698), fol.16^{b}.

6. Naṣīr al-Dīn Ṭūsī (1330 A.H.), Faṣl 6th; see also Encyclopaedia of Islam, Djalālī entry.

7. Zīj-i Ashrafī (Paris 1488), fol.4^{b}.

8. See Naṣīr al-Dīn Ṭūsī (1330 A.H.), Faṣl 6th.

of the calendar-year (Nawrūz) at the start of spring (vernal equinox) (1). After the reform, the first day of the new calendar-year was thus always the day by noon of which the sun had entered Aries (2). This is, in fact, the definition of Nawrūz of the new calendar given by Naṣīr al-Dīn Ṭūsī (3), Ulugh Beg (4), and many other authors of later centuries. Bīrjandī (5), in his commentary on Ulugh Beg's astronomical tables, and Mullā Muẓaffar (6) in his commentary on Bīrjandī, in common with many other commentators on earlier sources (7), add to the above definition an elucidatory phrase "Nawrūz-i Sulṭānī is the day at the noon of which the sun was already in the first degree of Aries, provided that it had been in Pisces on the preceding day". In order to differentiate the first day of the new calendar from that of the Yazdgirdī calendar, the Jalālī New Year was called variously "Nawrūz-i Sulṭānī", "Nawrūz-i Malikī" and "Nawrūz-i Ḥamal"(8), the latter name indicating directly that Nawrūz coincided with the sun's entry into Aries. Although the astronomical point by which the Nawrūz-i Sulṭānī was determined was (and still is) the noon meridian, this does not mean that New Year's Day was to begin at midday (9). To astronomers the noon meridian was, in fact, the starting point of the nychthemeron, but celebration of Nawrūz, the great Iranian festival, has always begun at sunrise. The midnight meridian is, however, now regarded as the starting point of the nychthemeron, but the noon meridian has been retained as the dividing line between one calendar year and the next. The original adoption of the noon meridian, with its relative time-difference across the country, could, prior to the advent of means of instantaneous communication, produce certain difficulties in time-reckoning: it was possible (and this in fact occurred) for two different days to be taken as Nawrūz in two cities of widely-differing longitudes if the sun's entry into Aries occurred at or close to the noon meridian. Assuming that Nawrūz of A.J.3 was on a

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1. Zīj-i Ilkhānī (O.2.(7)), fol.15^{b}; (Add.7698), fol.16^{b}; Bīrjandī (Ethe 2237), folios 23^{a-b}; see also Mīnovī (1312 H.S.), p.89.

2. Zīj-i Ilkhānī (O.2.(7)), fol.15^{b}; (Add.7698), fol.16^{b}; Bīrjandī (Ethe 2237), folios 23^{a-b}.

3. Zīj-i Ilkhānī (O.2.(7)), fol.15^{b}; (Add.7698), fol.16^{b}; (1330 A.H.), Faṣl, 6th.

4. Ulugh Beg (1847), p.310; see also Ideler (1826), pp.534-536.

5. Bīrjandī (Ethe 2237), folios 23^{a-b}.

6. Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 4.

7. Sharḥ-i Sī-faṣl (Add.7700), fol.12^{b}.

8. Mullā Muẓaffar (1267 A.H.), Bāb 2nd, 4; see also Ideler (1826), p.545; Ginzel (1906), p.301.

9. Cf. Barani (1943), p.171.

Sunday, on which the sun's entry into Aries happened to occur before midday, say 11.45 a.m. Iṣfahān local-time, on the same day at Marv the sun would be directly over the noon meridian but it would still be in Pisces. Consequently, whereas the above definition of Nawrūz-i Sulṭānī would make the said Sunday 1st Farvardīn (Nawrūz-i Sulṭānī) A.J.3 in Isfahan, use of the same definition at Marv would give the day as the 366th day of A.J.2.

In addition to the complicated question of "local-time", determination of Nawrūz also depended on the supposed length of the tropical year, for which astronomers have in the past determined differing durations (see Section I.IV.). It was, therefore, also possible for two different days to be designated as Nawrūz by two astronomers in different cities, or even the same city.

The above deficiencies in the Jalālī calendar would have been significant at a time when the telegraph and other means of instantaneous communication did not exist if the determination of Nawrūz had been purely in accordance with the above definition of Nawrūz-i Sulṭānī and if the astronomers responsible for the institution of the Jalālī calendar had not established adequate rules for the sequence of the leap and common years of the calendar. Such a supposition is put forward by Taqīzādeh, who expressed the belief that "the commencement of the year was to be found out every year by calculation"(1), but he quotes a formula from ʿAbd al-Raḥmān al-Khāzinī, who is said to be one of the eight astronomers in charge of Malik-Shāh's observatory and probably also of the calendar reform (2), for the determination of the leap and common years of the Jalālī calendar (3). According to Khāzinī, in order to establish whether a particular Jalālī year is a leap year or a common year, 172 should be added to the year in question; this result should then be multiplied by 53 and finally divided by 220. If the remainder is 53 or more, the year is a common year; if it is less than 53, the year will be a leap year (4). The above formula implies that the regulation of the Jalālī leap years must have corresponded to the same formula. Khāzinī's figure of 220 represents the intercalation-cycle, consisting of 53 leap years (366 days) and 167 common years; the figure 172 represents the first year of the first intercalation-cycle (see below). According to Khāzinī's formula, the distribution of the two kinds of year over each cycle of 220 years consists of three periods of 25 years, each including 19 common and 6 leap years:

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1. Taqīzādeh (1940-1942), p.113; (1346 H.S.), p.199.

2. Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), pp.683 ff.

3. See Taqīzādeh (1940-1942), pp.114-115; (1346 H.S.), pp.201-202.

4. Khāzinī, apud Taqīzādeh (1940-1942), pp.114-115; (1346 H.S.), pp.201-202; Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), p.685.

$$\left(\frac{(19 \times 365) + (6 \times 366)}{25} = 365.24\right),$$

and five 29-year periods, each of 22 common and 7 leap years:

$$\left(\frac{(22 \times 365) + (7 \times 366)}{29} + 365.2413\right).$$

In the 25-year periods, after five leap years every fourth year (quadrennium), the sixth intercalation is after five years (quinquennium). The same applies to the 29-year cycle, but the quinquennial intercalation is the seventh leap-year. The average length of the Jalālī year in Khāzinī's cycle can be calculated as follows:

$[(3 \times 25)\ 365] + (3 \times 6) = 27{,}393$ days;

$[(5 \times 29)\ 365] + (5 \times 7) = 52{,}960$ days;

$27{,}393 + 52{,}960 = 80{,}353$ days;

$80{,}353 \div 220 = 365.240909$;

i.e. 365 days, 5 hours, 46 minutes, 54.5 seconds.

The average duration of the Jalālī year in the above cycle, compared with the true length of the solar year (365 days, 5 hours, 48 minutes, 46 seconds), is one day short in every 775 years. The difference between the average length of the year in the above cycle and the supposed length of the solar year, which according to Khāzinī himself is 365 days, 5 hours, 45 minutes, 44 seconds, indicates that Khāzinī's formula for the leap and common years of the Jalālī calendar is probably not calculated on the basis of his own supposed length of the true solar year, but rather represents the original intercalation-cycle in common use during Khāzinī's life-time (1). Table 14 shows the quadrennia and quinquennia of the Jalālī calendar, calculated according to Khāzinī's formula, from the Jalālī era up to A.J.1028.

It seems that the method of intercalation in the Jalālī calendar implicit in Khāzinī's formula was abandoned in later centuries. The establishment of the Marāgha observatory in the second part of the 13th century A.D.(2) resulted in advances in astronomy; the length of the true solar year was found to differ from that of the average length of the Jalālī calendar; modification of the intercalation system therefore became necessary. Naṣīr al-Dīn Ṭūsi, who was responsible for establishing the observatory and supervised all activities undertaken there relating to the method of intercalation in

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1. See Taqīzādeh (1940-1943), p.115; (1346 H.S.), pp.201-202.

2. Sayili (1960), pp.189 ff.; see also Boyle (1963), pp.244 ff.

the Jalālī calendar, states in Zīj-i Ilkhānī that, after the quadrennial leap-years had been repeated seven or eight times, the next leap year was postponed until the fifth year (1). According to Naṣīr al-Dīn, the first day of the Jalālī year (Nawrūz-i Sulṭānī) can be determined empirically.

Neither the number of quadrennial leap-years, nor the method of establishing the quadrennia and quinquennia, set forth by Naṣīr al-Dīn Ṭūsī are identical to those of Khāzinī, as already discussed. Naṣīr al-Dīn gives no further information concerning the Jalālī leap years, but does give a table in which the quadrennia and quinquennia of the first 295 Jalālī years are shown, as calculated by himself or by colleagues at the observatory. Since the number of quadrennial leap-years mentioned by Naṣīr al-Dīn in his commentary is not in agreement with the number of quadrennial leap-years given by the same author in the table of Jalālī leap-years in the same work (Zīj-i Ilkhānī, folios 15^b-16^a), it seems probable that the table was calculated by one of his colleagues, rather than by himself (2). Like many astronomers and historians of later centuries, Naṣīr al-Dīn has not been sufficiently precise, and has caused confusion regarding the six or seven-year intercalation-period in the table and the seven or eight years in the text. Notwithstanding this discrepancy, the table of Jalālī leap-years in Zīj-i Ilkhānī is reproduced in the present work; for the sake of brevity, it will be referred to either as Table 15 or as Ṭūsī's table.

A cursory comparison of Ṭūsī's table with a table calculated by the present writer using Khāzinī's formula (Table 14) shows clearly that the leap-year sequence is not the same in the two tables. The difference stems from the fact that the tables were calculated on the basis of different values of the true length of the solar year; it is also certain that they were not calculated for the same noon-meridian. If we assume that Ṭūsī's table was calculated for the noon-meridian at Marāgha and that Khāzinī's formula is valid either for Marv or Nīshābūr, the time-difference of nearly one hour between Marāgha in the North-West of Iran and Marv or Nīshābūr in the North-East (3) is sufficient to account for the difference between the two tables. In addition, one must bear in mind the two authors' different views on the precise moment of the sun's entry into Aries.

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1. Zīj-i Ilkhānī (O.2.(7)), fol.15^b; (Add.7698), fol.16^b.

2. The astronomers and scientists mentioned in various sources as being attached to the Marāgha observatory at one time or another are as follows: Naṣīr al-Dīn Ṭūsī, ʿAlī b. ʿUmar al-Qazvīnī, Muʾayyid al-Dīn al-ʿUrḍī, Fakhr al-Dīn al-Akhlāṭī, Fakhr al-Dīn al-Marāghī, Muḥyī al-Dīn al-Maghribī, Quṭb al-Dīn al-Shīrāzī, Shams al-Dīn al-Shīrvānī, Najm al-Dīn Dabīrān al-Qazvīnī, ʿAbd al-Razzāq b. al-Fūṭī, Athīr al-Dīn al-Abharī, Husām al-Dīn al-Shāmī, the Chinese astronomer Fau Munjī, and the two sons of Naṣīr al-Dīn Ṭūsī: Aṣīl al-Dīn and Ṣadr al-Dīn. See Sayili (1960), pp.187 ff.; Sarton (1953,b,II), pp. 1005-1006; Boyle (1963), p.253, n.253.

3. See Sarton (1953,b,II) p.15; see also Sayili (1960), p.177.

Whereas Khāzinī provided the formula but not the table calculated on the basis of the formula, Ṭūsī's table in Zīj-i Ilkhānī, on the other hand, appears without its formula, but in this case the formula can be calculated from the table.

The quinquennial leap-years in Ṭūsī's table are the Jalālī years 31, 64, 97, 130, 163, 192, 225, 258 and 291. Reckoning from the first quinquennium in the table (A.J.31), the interval between the first five quinquennial leap-years (A.J.31, 64, 97, 130, 163) is a regular 33 years. The next quinquennial leap-year is A.J.192 after a gap of 29 years, and for three remaining consecutive quinquennial leap-years the time-interval reverts to 33 years.

The obvious point at which to start examining Ṭūsī's table is the quinquennial year A.J.31. The length of time covered by the table can then be marked off with the quinquennial leap-years into shorter periods of 33 and 29 years. This is the first appearance of the 33-year period in Iranian time-reckoning. The mean length of the year during the 33-year periods is 365.2424 days:

$$\left(\frac{(25 \times 365) + (8 \times 366)}{33} = 365.2424\right)$$

i.e. 365 days, 5 hours, 49 minutes, 3.3 seconds. In Ṭūsī's table four periods of 33 years are followed by one of 29 years, aggregating to a major cycle of 161 years. The major cycle includes 39 leap years and 122 common years, the average length of the year over the whole cycle being 365.2422 days:

$$\left(\frac{(39 \times 366) + (122 \times 365)}{39 + 122} = 365.24223\right)$$

i.e. 365 days, 5 hours, 48 minutes, 49.1 seconds.

The average length of the Jalālī year in Ṭūsī's table is no more than 3 seconds in excess of the true solar year; the difference would accumulate to one day in every 28,800 years. Although a cycle of 128 years, consisting of three 33-year periods and one of 29 would produce an error of only one day in every 35,000 years:

$$\left(\frac{(31 \times 366) + (97 \times 365)}{31 + 97} = 365.24218\right)$$

i.e. 365 days, 5 hours, 48 minutes, 45 seconds, both intercalation systems are convenient and permit easy determination of leap years either in the past or in the future.

If we wish to know whether a particular year in the Jalālī calendar, up to A.J.295, the last year in Ṭūsī's table, was a leap year or common year, we must first add 3 to the year in question; then multiply the total by 39 (the number of leap years in each major cycle), and then divide the product by 161; if the remainder is less than 39, the year was a leap year. For example, taking the year A.J. 258:

258 + 3 = 261;

261 x 39 = 10,179;

10,179 ÷ 161 = 63 (Remainder 36).

Since the remainder is less than 39, the year A.J.258 was a leap year. Using the above calculation to determine the quadrennia and quinquennia of the Jalālī calendar up to A.J.295, the result will be found to correspond to Ṭūsī's table in every case.

Results obtained using the formula derived from Ṭūsī's table are not in agreement with the quinquennial leap-years appearing in a number of Taqīzādeh's works (1). According to Taqīzādeh, the fifth quinquennial leap-year in Ṭūsī's table is A.J.167 (which differs by four years from that obtained with the formula; a four-year time-difference produced periods of 25 years and 37 years in Ṭūsī's table). From this Taqīzādeh concludes that there is no discernible pattern in the table to suggest the existence of an intercalation-cycle (2). His source was a manuscript of Zīj-i Ilkhānī preserved in Paris, which the present writer has not been able to consult. The fifth quinquennial leap-year appears in an earlier copy of Zīj-i Ilkhānī (British Museum Or.7464, fol.16[a]) and several other copies of the same document, all of which clearly show the "alphabetical numerals" representing the figure as ڛ = QSJ = 163 (3).

The Jalālī calendar in its original form did not last long, but the location of Nawrūz-i Sulṭānī more or less at the vernal equinox has been maintained ever since its inception. Astronomers of later centuries followed neither Khāzinī's rule of intercalation nor Ṭūsī's table of quadrennial and quinquennial leap-years to regulate the leap and common years.

Ḥasan b. Ḥusain b. Ḥasan Shāhanshāh al-Simnānī, who wrote in A.H. 795 (A.D.1393) a commentary on Zīj-i Ilkhānī, gives a table of Jalālī leap-years for the first 443 years of the Jalālī era (4). The first 295 years of this table have been copied from Ṭūsī's table; al-Simnānī himself calculated the leap years for the later period up to A.J.443 (A.D.1521)(see Table 16). Although al-Simnānī, like Naṣīr al-Dīn Ṭūsī, considers the initial year of the first cycle of intercalation to be three years earlier than the era itself, and although his other principles of calculation were the same as those of Ṭūsī, his table is not

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1. Taqīzādeh (1940-1942), p.116; (1346 H.S.), p.203.

2. Taqīzādeh (1940-1942), p.116; (1346 H.S.), p.203. The argument proposed by Taqīzādeh in the Encyclopaedia of Islam, Djalalī entry, is based on the same misunderstanding of the Jalālī calendar.

3. See Zīj-i Ilkhānī (O.2.(7)), fol.16[a]; see also al-Simnānī (Add.23,568), fol.6[a].

4. Tawḍiḥ Zij-i Ilkhānī (Add. 11,636), fol. 6[a].

completely in agreement with the results of the formula derived from Ṭūsī's table. The quinquennial leap-years in al-Simnānī's table, (see Table 16) are the Jalālī years 320, 353, 386 and 419. The results using the formula are in agreement with the whole of the table, apart from the year A.J.320. In this case, use of the formula:

$$\left(\frac{(320 + 3)\ 39}{161} = 78;\quad \text{remainder } 39\right)$$

gives a remainder of exactly 39; it seems that al-Simnānī therefore regarded the year 320 as a leap year, whereas Naṣīr al-Dīn Ṭūsī regarded the year A.J.159 which produces the same result:

$$\left(\frac{(159 + 3)\ 39}{161} = 39;\quad \text{remainder } 39\right)$$

as a common year and the preceding year A.J.158:

$$\left(\frac{(158 + 3)\ 39}{161} = 39;\quad \text{remainder } 0\right)$$

as a leap year.

Unlike Khāzinī and Ṭūsī, Ulugh Beg (1) mentions the 33-year and 29-year periods for intercalation, but does not refer to any combination of these periods in a "major cycle". In conjunction with the supposed true length of the solar year, which according to Ulugh Beg was 365 days, 5 hours, 49 minutes, 15 seconds (2), use of the 33-year and 29-year, or any other periods, would result in a calendar-accuracy one tenth of that of Naṣīr al-Dīn Ṭūsī and al-Simnānī. The great Russian scholar Barthold, who refers to the Marāgha observatory by the name of its founder Naṣīr al-Dīn Ṭūsī, states that "Ulugh Beg's observatory was not destined to play the same part in the world of science as the observatory of Naṣīr al-Dīn Ṭūsī, which was built in Marāgha in 1259 A.D."(3). The same scholar is of the opinion that "Muslim astronomy in the later period (after the death of Ulugh Beg) stagnated, genuine astronomers disappeared, their place being taken by the almanac compilers (Muwaqqits)"(4), who relied on ocular observation. It was during this later period that ʿAbd al-ʿAlī b. Muḥammad Ḥusain Bīrjandī, who in A.H.929 (A.D.1523) wrote a commentary on Zīj-i Ulugh Beg, asserted that, since successive solar years are of unequal length, determination of leap and common years is only possible by annual observation (5). In spite of the fact that the Jalālī

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1. Zīj-i Ulugh Beg (1847), pp.310-311.

2. Ibid, p.313.

3. Barthold (1958,II), p.133.

4. Barthold (1958,II), p.134.

5. Bīrjandī (Ethe 2237), fol.24[a]. See also Taqīzādeh (1940-1942), pp.116-117; (1346 H.S.), p.204.

calendar is based on the mean length of the astronomical solar year, and that intercalation in this calendar at first followed a scientific rule, the Muwaqqits and court astronomers of the 15th century A.D. onwards, like the Roman pontifices of the pre-Christian period (1), became responsible for determining the leap and common years of the Jalālī calendar, a task which they performed in an arbitrary way.

Determination of the leap and common years over the last five centuries, together with the various methods of time-reckoning employed during this period, will be considered in Sections IV.IV and IV.V.

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1. See Fotheringham (1931), p.738.

IV.V. The calendar of the duodecennial animal-cycle

Lille University recently published a book of some 800 pages, written by Dr. Louis Bazin (1), devoted to the calendar of the duodecennial animal-cycle. The sixth chapter of this work (pp.531-602) deals with the duodecennial animal-cycle described in Islamic sources. In the same chapter, the author exhaustively treats the sinological aspects of some of the Chinese-Uyghur terms, which were transliterated into Arabic characters and used as technical terms in Islamic sources (2). Regarding the calendar itself, Bazin concludes that all the features of the Uyghur calendar, as described by Ulugh Beg, are identical to those of the indigenous Chinese calendar (3). Having consulted an inadequate résumé of Ulugh Beg's astronomical tables by Osman Turan (4), and being evidently unaware either of the publication of a similar but more comprehensive work by Sédillot with extensive annotation in Persian, Arabic and French (Paris 1847), or of the translation of Ulugh Beg's text into French by the same author (Paris 1853)(5), Bazin is of the opinion that Ulugh Beg in the middle of the 15th century A.D. continued at a high scientific level the centuries-old tradition of the Turkish Uyghur and Uyghur-Mongol calendar, taken directly from the Chinese tradition, and that he was well aware that he was so doing (6). Bazin adds that "thanks to him (Ulugh-Beg), this tradition was made available, in the most exact form, to the Islamic world"(7).

It is not our intention to deal here with the indigenous Chinese-Uyghur calendar, which is neither relevant nor within our scope. There are, however, a few points which are perhaps worth raising over the arguments put forward by Bazin.

Apart from scattered information relating to the Chinese-Uyghur duodecennial animal-calendar provided by Bīrūnī (8) and Maḥmūd Kāshgharī,

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1. See Bibliography.

2. Bazin (1974), pp.537-550.

3. Ibid, pp.534, 601.

4. Ibid, p.601.

5. See Kennedy (1956), pp.125-128; (1964), pp.442-443; see also Zīj-i Ulugh Beg (1947), pp.1 ff.

6. Bazin (1974), p.601; cf. Barthold (1958, II), pp.129-134.

7. Bazin (1974), p.601; where he states that "a complete edition of this work is much to be desired".

8. See Bīrūnī (1879), p.82; (1352 H.S.), pp.105-106; also Taqīzādeh (1346 H.S.), p.471.

both of whose works have been studied by Osman Turan (1) and Bazin (2), Naṣīr al-Dīn Ṭūsī is the first Moslem astronomer to describe this calendar scientifically. The first chapter of Zīj-i Ilkhānī (Maqālat-i Awal), which is devoted to this calendar, begins with the words: "The calendar which is used by our kings (the Ilkhānīds), is the calendar of the Qitā (Khitā) and the Turks (3), whereas those which are used in our provinces are the 'Tārīkh-i Rūmīyān' (Seleucid), 'Tārīkh-i ʿArab' (Arabian lunar-Hijrī), 'Tārīkh-i Pārsīyān' (Yazdgirdī), and the 'Tarīkh-i Muḥdath (Jalālī), which has been established by Malik-Shāh"(4). There is nothing obscure in this quotation, which clearly indicates that the Chinese-Uyghur calendar was not used by the Iranian people themselves.

According to Banākatī, who briefly describes the indigenous Chinese-Uyghur calendar, the information relating to this calendar was first obtained by Naṣīr al-Dīn Ṭūsī from an astronomer and scientist named Fau Munjī (5) (according to Boyle "This was one Fu Mêng-chi or Fu Mu-chai, who came to the West in Hülegü's suite")(6). A similar report, but with a completely different name for the Chinese astronomer, appears in a marginal note in "Bīst Bāb-i Mullā Muẓaffar". According to Mullā Muẓaffar, "a person by the name of Mīr-Siljī-Khān, who was known as 'Sīg-sīg' which means ʿārif (sage), had described the features of the calendar for Sulṭān al-Muḥaqqiqīn (i.e. Naṣīr al-Dīn)"(7). The latter statement is repeated in Tārīkh-i Banākatī, where the appellation of Fau Munjī appears as "Sīng Sīng"(8). According to Boyle, "Sīng Sīng" no doubt represents "hsien-shêng", the customary honorific for a scholar, teacher or gentleman (9).

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1. Osman Turan, Oniki Hayavanli Turk Takvimi, Istanbul, 1941, p.58; see also Taqizadeh (1317), p.2, n.2.

2. Bazin (1974), pp.532 ff.

3. On Khitā or Khita or Qita, see Barthold (1958,I), pp.26-27; Bīrūnī (1316-1318 H.S.), p.199; Mullā Muẓaffar (1267 A.H.), Bāb 14, marginal annotation; Minorsky (1942), p.14.

4. Zīj-i Ilkhānī (Add.7698), fol.3^{b}; (O.2.(7)), folios 3^{a-b}; see also Zīj-i Jadīd-i Sulṭānī (Ethe 2233), fol.8^{b}.

5. Tārīkh-i Banākatī (1348 H.S.), p.238; the name of the Chinese astronomer Fau Munjī (فونجی) is written in the British Museum MS. ((Add. 7626), fol.117^{b}) as "موجی" with no dot on "ف" but three dots under "ج". Elsewhere ((Add.7627), fol.126^{a}) the name is written "فوضی"; it appears as "توشی" with no dot at all in the Tehran version of the same work, published by Sheār in 1348 H.S.

6. Boyle (1963), p.253, n.4.

7. Mullā Muẓaffar (1267 A.H.), Bāb 14, marginal annotation to Tārīkh-i Khatā'īyān.

8. Tārīkh-i Banākatī (1348 H.S.), p.238.

9. Boyle (1963), p.253, n.4.

Mullā Muẓaffar, in the same note, states that Naṣīr al-Dīn Ṭūsī, at the instigation of Hulāgū, included the "rules" of the above calendar in Zīj-i Ilkhānī; that later Ulugh Beg, in imitation of Naṣīr al-Dīn, repeated them in his Zīj; and that this calendar has since become known in Iran. Either the information provided by Mullā Muẓaffar is derived from Tārīkh-i Banākatī, or both are from the same original source, the difference between the two reports being attributable to carelessness on the part of Mullā Muẓaffar or of those copying his work. Mullā Muẓaffar's report appears with appreciable variations in different copies of his work, e.g. in two lithographic prints published in A.H.1276/A.D.1859 and A.H.1298/A.D.1881 respectively (1).

The descriptions of the indigenous Chinese-Uyghur calendar appearing in Islamic sources subsequent to Zīj-i Ilkhānī must have been taken from Zīj-i Ilkhānī itself. Kennedy (2), in a chronologically arranged list of Islamic sources for Chinese calendar studies, in which the indigenous Chinese-Uyghur calendar is placed in the period between Naṣīr al-Dīn Ṭūsī and Ulugh Beg, cites seven astronomical tables (Zījāt), including Zīj-i Muḥyī al-Dīn al-Maghribī (completed in A.H.675; A.D.1276)(3) and Zīj-i Khāqānī of Ghīyath al-Dīn Jamshīd b. Mas'ūd al-Kāshī, who was one of the most distinguished astronomers invited by Ulugh Beg to collaborate at his observatory at Samarkand (4). Zīj-i Khāqānī, which is a commentary on Zīj-i Ilkhānī, must have been used at the Samarkand observatory (5). The information relating to the Chinese-Uyghur calendar appearing in Zīj-i Ulugh Beg is taken either from Zīj-i Ilkhānī or Zīj-i Khāqānī, but the existence of many identical statements in works written later than Zīj-i Ilkhānī makes it difficult to be certain of Ulugh Beg's source.

In the same article, which is entitled "The Chinese-Uyghur calendar as described in the Islamic sources", Kennedy, who acknowledges his debt to Kiyosi Yauuti of the University of Kyoto and speaks of him as the "human key" to Chinese astronomical sources (6), states that all the features of the Chinese-Uyghur calendar described in Islamic sources, with one single exception, are identical to those of the

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1. Mullā Muẓaffar (1276 A.H.; 1298 A.H.), Bāb 14, marginal annotation.

2. Kennedy (1964), pp.442-443.

3. Muḥyī al-Dīn Maghribī is also the author of Risāla al-Khitā va Uyghur, which is devoted to the chronology of these people. It seems that the attribution of a work of a similar name to Naṣīr al-Dīn Ṭūsī by Bazin (1974), p.534), who claims that Naṣīr al-Dīn's work is lost, is due to his misunderstanding; see Sarton (1953,b,II), p.1016; Mudarrisi(1335 H.S.), pp.79-80.

4. See Barthold (1958,II), pp.130-131; see also Sayili (1960), p.266.

5. See Barthold (1958,II), pp.130-131.

6. Kennedy (1964), p.436.

indigenous Chinese calendar (1); the exception is the mean length of the anomalistic months, which is given in Zīj-i Khāqānī as 27.555 days (27 days, 19 minutes, 12 seconds), whereas the length of the same period is given in Chinese works from the second century A.D. onwards as 27.5546 (27 days, 18 minutes, 37 seconds)(2). The difference of nearly 35 seconds for the mean length of the anomalistic months, which are by definition of extremely varied duration, has in fact no significance in time-reckoning (see Section I.II).

There can be no doubt that the indigenous Chinese-Uyghur calendar was never used by the Iranians, either during the Mongol period or later. The only instance of its use is the mention of several dates by Rashīd al-Dīn, all within the early Mongol period (3). Naṣīr al-Dīn Ṭūsī gives a comparative table for the conversion of indigenous Chinese-Uyghur dates to the Arabian lunar-Hijrī calendar in this period (4). Ulugh Beg, in his Zīj, consistently differentiates between the time-reckoning of the people of Khitāī and Uyghur and that of the people in his own domain (5). The account given by Mullā Muẓaffar, who lived during the reign of Shāh ʿAbbās I (A.H.996-1038; A.D.1587-1629), also suggests that the Chinese-Uyghur calendar was not in use in later centuries (6). This does not mean that the duodecennial animal-cycle did not exert an influence on the Iranian calendar. To establish the nature of this influence, one must first start by examining the various methods of time-reckoning which had been used by the Iranians prior to the Mongol occupation.

From the time of the appearance of Islam in Iran, the Arabian lunar-Hijrī calendar (which has received so much study (7) that it has been deliberately omitted from the present work) gradually became more widely-used; at the time of the Mongol invasion, it was the most commonly used calendar. The religious connection of the era of this calendar (1st Muḥarram of the year of the flight of the prophet Moḥammed), and the regulation of religious ceremonies and prayers by

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1. Kennedy (1964), pp.437, 441.

2. Ibid, p.437.

3. See Boyle (1971), p.x.

4. Zīj-i Ilkhānī (O.2.(7)), folios 11^{a-b}; see also Qazwīnī (1329 A.H.), pp.102-103, n.3.

5. Zij-i Ulugh Beg (1847), pp.314-315, 317, 320, 332.

6. Mullā Muẓaffar (1267 A.H.), Bāb 14.

7. A precise description of the lunar-Hijrī calendar may be found in Bīrūnī's works or in most Arabic and Iranian astronomical literature. See also Freeman-Grenville(1963), pp.1 ff.; Humā'ī (1340 H.S.), pp.399-409.

it, endowed it with an aura of sanctity. Changes to this calendar were not welcomed by the Iranian Moslems, who believed that it was contrary to the teaching of the Koran (Ch.ix, vs.35, 36): "Allah ordained the months twelve in number when He created the heavens and the earth. Of these four are sacred, according to the true faith. Therefore do not sin against yourselves by violating them. But you may fight against idolators in all these months since they themselves fight against you in all of them. Know that Allah is with the righteous. The postponement of sacred months is a grossly impious practice, in which the unbelievers are misguided. They allow it in one year and forbid it in the next, so that they may make up for the months which Allah has sanctified, thus making lawful what Allah has forbidden. Their foul acts seem fair to them: Allah does not guide the unbelievers"(1).

Bazin is of the opinion that the Moslems, being unaware of the science of astronomy, on which the calendar of the duodecennial animal-cycle is based, rejected this calendar because they regarded it as a relic of the time when the Turks were still animal-worshippers (2). It should be emphasised, however, that, if there was resistance to the use of the original Chinese-Uyghur duodecennial animal-calendar, this was because the employment of any kind of lunisolar calendar in which intercalation is essential was forbidden by the Koran. Only during the Ṣafavid period, nearly four centuries later than the Mongol invasion, were objections first raised against the Chinese-Uyghur duodecennial animal-calendar. It was the common contemporary practice to name lunar-Hijrī years by this animal-cycle that prompted objections from members of the clergy (3).

The only feature of the Iranian solar calendar which had survived throughout the Islamic period was the festival of Nawrūz. This was generally celebrated during the initial period of "occupation" of Iran by the Arab Moslems (4). Although the Umayyad, and subsequently the ʿAbbāsid rulers of Iran were strongly opposed to any manifestation of Zoroastrianism or observance of any tradition from the pre-Islamic period, it would nevertheless appear that the ʿAbbāsid caliphs were reluctant to forbid the celebration of Nawrūz because of the gifts which they traditionally received on this day (5). Attempts were made by Muʿtaḍid to establish a "Nawrūz" (Arabic "Nīruz") in his own name, on which both Arabs and Iranians were to celebrate New Year's Day (6).

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1. See translation of Koran by Davood, London, 1974, p.324. See also Bīrūnī (1879), p.37; (1352 H.S.), p.52; (1934), p.164; (1316-1318 H.S.), pp.223-227, p.224, n.7; Ḥamza (1346 H.S.), p.3; Taqīzādeh (1317 H.S.), p.159; (1346 H.S.), p.193, n.2.

2. Bazin (1974), p.533; cf. Chardin (1338 H.S.), pp.193-197.

3. See Chardin (1338 H.S.), pp.193-197.

4. Frye (1975), pp.2, 140.

5. See Zarrīnkūb (1343 H.S.), p.453.

6. Bīrūnī (1879), p.258; (1352), p.358; see also Humā'ī (1340 H.S.), pp.395-398.

Despite Mu'taḍid's efforts, and in spite of the stabilization of its location (11th June) in relation to the solar year by the adoption of the Julian method of intercalation, which had been forcefully requested by the Iranian tax-payers (see Section IV.III), Mu-'taḍid's Nawrūz did not become firmly established. The reason traditionally propounded for the many attempts at stabilizing Nawrūz during the first five centuries of the Islamic period is that the Iranian 365-day calendar was used for tax-collection (see Section IV.III), and that the intercalation of one month in every 120 years, which had been performed in pre-Islamic times (1), was no longer implemented after the advent of Islam (see Section IV.I); consequently, at this period, Nawrūz, the "due date" for payment of taxation "in kind", fell inconveniently before the harvest (2). The last, and decisive, remedy for this deficiency was elaborated by astronomers of the early 11th century A.D. in the form of the Jalālī (true-solar-year) calendar (see Section IV.IV). Although Nawrūz was no longer regarded as the starting point for tax-collection, the new due date was also stabilized in relation to the harvest-season by the new calendar (see Section IV.IV).

After the eventual abandonment of the Jalālī calendar, the Arabian lunar-Hijrī calendar became the official calendar for both religious and secular purposes. We are told by Banākatī, who completed his work in A.H.717 (A.D.1317/1318)(3), that the method of time-reckoning by which the records of tax-collection had been kept before the reign of Ghāzān Khān was the Arabian lunar-Hijrī calendar (4). At that time the Iranian peasants had constantly complained about taxation related to the Arabian method of time-reckoning, which caused them to pay taxes 33 times in roughly every 33 lunar years, whereas in the same period they harvested their agricultural products, naturally governed by the solar year, only 32 times (5).

It should be noted that this complaint, which is also recorded by other historians of the Mongol period (6), is not the same as the complaint in the pre-Mongol period, when the problem was that of the gradual shift of Nawrūz; these two sources of discontent belong to separate periods, despite the confusion apparent in modern literature on the subject (7).

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1. See Bīrūnī (1934), pp.185-186; (1316-1318 H.S.), pp.270-271.

2. Ibid.

3. Qazwīnī (1912), pp. "›" (d; 4), xvi.

4. Banākatī (1348 H.S.), p.26.

5. Ginzel (1906), pp.264-265, n.1.

6. Ibid.

7. Taqīzādeh (1317 H.S.), pp.156 ff.; (1937), pp.905-916; (1346 H.S.), pp.164-179.

According to Banākatī (1), Ghāzān Khān (A.H.694-703; A.D.1295-1304) ordered his minister Rashīd al-Dīn to produce a better calendar for tax-collection records. Full details of the calendar are to be found in several works by Taqīzādeh; its main characteristics are also described by Sayili (2), who had access to a manuscripf of Zīj-i Muḥaqqaq-i Sulṭānī ʿalā Uṣūl al-Raṣad al-Ilkhānī, compiled by al-Wābkānwī (3), preserved in Istanbul. Sayili, drawing on al-Wābkānwī, one of the astronomers responsible for the calendar (4), states that the names of the Turkish months were used in the new calendar and that New Year's Day was taken to be the day on which the sun's entry into Aries occurred before sunset; if it occurred after sunset, the next day was regarded as the first day of the year (5). The report given by Banākatī also indicates that the first day of the year in the Ghāzānī calendar was taken to be Nawrūz (6). Banākatī makes no mention of the use of the Turkish months. However, the equivalent Ghāzānī date of Nawrūz in A.H.1005 given by Mullā Muẓaffar confirms al-Wābkānwī's report (7).

A new era was also established for this calendar. Curiously, different dates are given by contemporary historians for the precise lunar-Hijrī date corresponding to the era. Taqīzādeh, who studied the question through the most reliable sources available, is of the opinion that the year concerned is A.H.701 (A.D.1302; A.J.224)(8). This is the date also arrived at by Ginzel, on the basis of relevant reports by Waṣṣāf and Ḥamd-Allāh Qazvīnī (9). Banākatī, of whom there is no mention in the works of Ginzel, Taqīzādeh or Sayili, gives the equivalent date of the Ghāzānī era as "a Tuesday in A.H.699"(10).

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1. Banākatī (1348 H.S.), p.26.

2. Taqīzādeh (1317 H.S.), pp.161, 163-164; (1940-1942), pp.117-120; (1346 H.S.), pp.206-210.

3. Sayili (1960), p.229. The full name of al-Wābkānwī is given in Zīj-i Shāhjahānī ((Or.372), fol.3[a]) as Imām Muḥammad b. Khwāja ʿAlī Wābkānwī; his work is also referred to as Zīj-i Sulṭānī.

4. Sayili (1960), pp.229-231.

5. See Sayili (1960), p.231; cf. Taqīzādeh (1317 H.S.), pp. 163-164.

6. Banākatī (1348 H.S.), p.26.

7. Mullā Muẓaffar (1267 A.H.), Bāb 14th.

8. Taqīzādeh (1317 H.S.), pp.163-164; (1346 H.S.), p.546.

9. Ginzel (1906), pp.304-305.

10. Banākatī (1348 H.S.), p.26.

The report of al-Wābkānwī, quoted in Sayili's work, indicates that the Ghāzānī calendar, although in use in official Ilkhānid circles during the reign of Ghāzān's successor Abū Sa'īd (A.H.716-736; A.D.1316-1335), was not in general use in the same period (1).

Rashīd al-Dīn, the most distinguished historian of the period, although responsible for producing the new calendar, did not use it himself (2). The method Rashīd al-Dīn uses for dating throughout his history is usually the Arabian lunar-Hijrī calendar (3); occasionally he gives the corresponding indigenous Chinese-Uyghur dates (4), and rarely dates with the month-names of the zodiacal signs (5). The account by this historian/minister of the method of tax-collection at the time of Ghāzān Khān clearly indicates that the true solar year was used for this purpose and that Nawrūz-i Jalālī was the "due date" for certain taxes (6).

We must now return to the calendar of the duodecennial animal-cycle which came into use among the Iranians (which will be referred to as the Iranian duodecennial calendar). The Persian literature of the post-Mongol period contains numerous dates by this calendar (7), which permit its nature to be determined conclusively. The calendar in fact combines features of the Arabian lunar-Hijrī calendar, the Jalālī calendar, and the (Turkish) calendar of the duodecennial animal-cycle. During the period of seven centuries in which this calendar was in use, i.e. from the Mongol invasion up to the early years of the present (Christian) century, certain modifications occurred. Let us therefore consider the characteristics of the calendar, as derived from the above three earlier calendars.

The era by which the years are reckoned and the month-names in the Iranian duodecennial calendar originate from the Arabian lunar-Hijrī calendar. The months are true lunar months; the start of the month was determined by direct observation of the new moon. Consequently, in this calendar, the two features of the Arabian lunar-calendar, i.e. its era, directly connected with the Prophet of Islam, and the lunar months, the changing of which was contrary to Koranic teaching (see p.162), were adopted in their original form. Almanac-compilers have employed hollow months in their calendars, a method which is still common; in some cases the days of a particular month, as observed by the people, are not the same as those appearing in almanacs (see Section I.II).

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1. Sayili (1960), pp.229-230; Ginzel (1906), pp.305-306.
2. See Boyle (1971), p.x.
3. Ibid.
4. Ibid.
5. Rashīd al-Dīn (1957), pp.473.
6. Ibid.
7. See Minorsky (1942), pp.21, 80-81.

The first day of the year of the duodecennial animal-cycle calendar was observed on Nawrūz of the Jalālī calendar; the length of the year was therefore supposed to be that of the true solar year. An allusion was made earlier to the almanac compilers of the post-Mongol period, whose determination of Nawrūz was not based on any particular rule (see p.156); we can now consider the method they used to determine the Nawrūz of the new calendar. The location of the Nawrūz of the Iranian duodecennial calendar, during the greater part of the reign of Shāh ʿAbbās I, is given by Iskandar Munshī in "Tārīkh-i ʿĀlam-ārā-yi ʿAbbāsī" by the Arabian lunar-months (1). In most cases, he gives the supposed true instant of the sun's entry into Aries (2). It is possible to calculate the length of each year of this period from the information given by Iskandar Munshī. For example, the precise instant of the sun's entry into Aries is given by him for the years A.H.1036 (3) and A.H.1037 (4) as 8.17 a.m. and 2.20 p.m., respectively; accordingly, the length of the Iranian duodecennial year 1036 is 365 days, 6 hours, 3 minutes, which is more than 15 minutes longer than the true length of the solar year (see Section I.IV). Chardin, who was a contemporary eye-witness, states that there was sometimes a difference of one hour between the calculations of European and Iranian astronomers of the precise instant of the sun's entry into Aries (5). The astronomers of the period do not appear to have followed any particular rule for the leap and common years of this calendar; since the leap and common years were not regulated, and since the astronomers of that time were uncertain as to the true length of the solar year, it is virtually impossible to give corresponding dates for this calendar with any degree of certainty.

The adoption of the solar months in the Iranian duodecennial calendar was also in imitation of the Jalālī calendar (see Section IV.IV). The solar months were used for financial affairs. The "due date" for the payment of the second instalment of the pastoral tax "qupchur" (qupchir)(6) is placed by Rashīd al-Dīn in the second part of the year, beginning with the sun's entry into Libra (7). During the Ṣafavid period, when the Iranian duodecennial calendar with the Arabian lunar-months was in general use, the solar months also appear

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1. Iskandar Munshī (1350 H.S.), pp.381 ff.; see also Minorsky (1942), p.81.

2. Iskandar Munshī (1350 H.S.), pp.447, 886, 919, 930, 944, 948, 957, 992, 1011, 1023, 1043, 1059, 1073.

3. Ibid, p.1059.

4. Ibid, p.1073.

5. Chardin (1338 H.S.), p.138.

6. On "qupchur" or "qupchir", see Petrushevsky (1344 H.S.), pp.228-229; see also Boyle (1971), p.55.

7. Rashīd al-Dīn (1957), p.473.

in almanacs. The method of determining the solar months, as part of the data traditionally supplied in Iranian almanacs, is adequately explained in literature concerning the composition of almanacs (1). Among the Persian printed collections at the British Museum, there are two official Iranian calendars for the years A.H.1290/A.D.1873 and A.H.1291/A.D.1874 (2), in which the precise instant of the sun's entry into each sign of the zodiac is given. Thus the time taken by the sun to cross a single sign, which by definition is one month, is shown in these two calendars. The month-names, which are those of the zodiacal signs, are also given alongside other month-names. The solar months were officially adopted in A.D.1911 (3) and continued in use up to A.D.1925, when a reform of the official Iranian calendar was instituted (see Section IV.VI).

In spite of the objections of clergy of the Ṣafavid period, one feature of the duodecennial animal-calendar which survived in dating over the ages (and even today survives in certain almanacs) is the appellation of the Iranian calendar-years by the duodecennial animals, using their Turkish names, and occasionally using the Persian names for the same animals (see Table 17).

As the above implies, each year of the Iranian duodecennial animal-cycle calendar is called after one of a series of animals, in the order shown in Table 17. In every cycle of 33 or 34 lunar years, by which the years are reckoned from the era of the Hijrā, one (popular) lunar year is omitted to re-adjust the appellation of the years to keep in pace with thenames currently allotted to the (official) solar years by the Iranians and also to the luni-solar Chinese-Uyghur calendar. The omission of a lunar year, which is called in Arabic "Izdilāq" (generally translated either as "skipping" or "sliding")(4), is explained by Waṣṣāf, the historian of the Mongol period (5); an allusion to it is also made by Banākatī (6). The most satisfactory explanation of this method is to be found in Poole's work on the subject of "The Coins of the Shāhs of Persia"(7), which has yet to receive the full credit which is due to it. The main points may be summarized as follows:

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1. See Mullā Muẓaffar (1267 A.H.), Bāb 3rd.

2. See Bibliography: Sāl-nāma-yi Irān (14,837,b,5,6).

3. The legislation for this reform was enacted on 21st Safar A.H.1329 (20th February 1911; 1st Isfand S.H.1289).

4. Taqīzādeh (1317 H.S.), p.160, n.319; (1937), p.908; (1346 H.S.), pp.170-171.

5. See Ginzel (1906), pp.265, n.1; also Taqīzādeh (1937), p. 913; (1346 H.S.), pp.175-176.

6. Banākatī (1348 H.S.), p.26.

7. Poole (1887), pp.xviii-xx.

The years of the Iranian duodecennial calendar, beginning on the Jalālī Nawrūz and ending on the day before the next Nawrūz, are named after each of the twelve animals in turn. Since, at the same time, the era by which the years are reckoned is the era of the Hijra, in order to keep the lunar and solar year-reckoning in harmony when an Arabian lunar year happened to lie completely within a solar year, that lunar year is dropped as far as the animal-cycle is concerned. The example given by Poole, and repeated by Osman Turan (1) and Bazin (2), is the year A.H.1153, which contains no Nawrūz and was therefore omitted; following the year A.H.1152, dedicated to the Monkey (ninth in the sequence), the lunar year jumps to 1154, named after the Hen (tenth).

The periodic correction does not, however, appear to have been implemented regularly. An obvious example of such neglect is the year A.H.1019, appearing in "Tārīkh-i ʿĀlam-ārā-yi ʿAbbāsī", for which the explanation is rather complicated but is worthy of closer examination here.

It has already been mentioned that the years of the chronicles of Shāh ʿAbbās I, as given by Iskandar Munshī, begin on Nawrūz-i Jalālī and are reckoned from the era of the Hijra and also by the regnal years of the same king. Iskandar Munshī furthermore associates each year with one of the animals of the cycle; in some cases the same animal is allotted to two consecutive years. In such a case, the formula is as in the following example:

"وقایع ایت نیل مطابق ثمان عشر والف وبعضها موافق تسع عشر والف
که مبدء سال بیست وچهارم اقدس همایونست"

This is the chronicle-heading for the year A.H.1018, which, according to Iskandar Munshī, begins on Sunday 25th Dhū'l-Ḥijja A.H.1018 and may be translated as "The events of the year of the Dog partly corresponding to A.H.1018 and partly to A.H.1019 which is the beginning of the 24th year of the reign of Shāh ʿAbbās I"(3). The next year, according to the same author, begins on the first day of Farvardīn-i Jalālī, corresponding to 6th Muḥarram A.H.1020; he designates this year the year of the Pig (4). It appears at first sight that no animal is allotted to the year A.H.1019, which does not contain Nawrūz, but closer examination proves that this is not so. Since the same author dedicates the years A.H.1015 and A.H.1021 to the Horse (5) and Mouse (6), if the intervening years are counted, it is

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1. Osman Turan (1941), p.58 (see above, p.159, n.1).
2. Bazin (1974), p.600.
3. Iskandar Munshī (1350 H.S.), p.807.
4. Ibid, p.829.
5. Ibid, p.713.
6. Ibid, p.853.

clear that he must have considered the year A.H.1019 to be the year of the Dog. Curiously, Iskandar Munshī, in the introduction to the second volume of his work, criticizes those historians who give dates according to the lunar-Hijrī calendar; he defines his own method as the duodecennial Turkish calendar (1), but, as we have seen, he does not in practice observe any particular calendar in his chronicles: he attributes events to certain solar years, at the same time allotting animals to lunar years. Although the method adopted by Iskandar Munshī is unsystematic and the animals allotted to the lunar-Hijrī years of A.H.1020 onwards do not correspond to those of the Chinese-Uyghur calendar, it is still possible to derive a simple formula for this method of application of animal-designations to the lunar-Hijrī years. If we wish to know the animal associated with a particular year, we must divide the year in question by 12; the remainder represents the animal in the cycle, i.e. Mouse = 1, Ox = 2, Tiger = 3, and so on, up to 11, which represents the Dog; if the remainder is 0, it represents the year of the Pig, the last animal in the cycle (see Table 17).

Lunar-Hijrī dates appear throughout Iranian literature of the post-Mongol period, expressed in the form of the animals of the duodecennial cycle. These animals are those contemporaneously allotted to the corresponding years of the Chinese-Uyghur calendar. The dates appearing in "Ẓafar-nāma", "Tārīkh-i Gīlān", "Aḥsan al-Tawārīkh", "ʿAbbās-nāma"(2), and also in letters and contracts of the post-Mongol period up to the 18th century, are expressed in this form.

Of the various methods proposed by astronomers and historians, the following is the easiest for determining the animal in the cycle corresponding to the year in question. If we wish to find the animal associated with a particular year, we must first convert the year in question to a Christian date, then subtract 3 from the Christian year; the product must be divided by 12; the remainder represents the animal in the cycle, as mentioned earlier.

Naming the years by the duodecennial animals is still common in certain Iranian almanacs. In order to determine the animal to which a solar-Hijrī year is dedicated, we must first add 6 to the year in question; the product must then be divided by 12; as before, the remainder represents the animal in the cycle.

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1. Iskandar Munshī (1350 H.S.), pp.379-380.

2. See Bibliography.

IV.VI. Hijrī era with solar year and Shāhanshāhī calendar

The institution of the Hijrī era and solar year, which is variously called "Taqwīm-i Hijrī-i Shamsī" and "Taqwīm-i Shamsī-i Hijrī", is a comparatively recent development. The legislation by which it became the official Iranian calendar was enacted by Parliament on 11th Farvardīn H.S.1304 (31st March A.D.1925); it continued in use until 24th Isfand H.S.1354 (14th March A.D.1976), when a new era, based on the supposed date of accession of the first Achaemenid king, Cyrus the Great (559 B.C.), which was declared to be year 1 of the national calendar, was approved by Parliament. The form of the calendar itself was unchanged. The difference between the era of the solar-Hijrī calendar and that of the present national Iranian calendar (Shāhanshāhī) is therefore simply 1180 years.

The era by which the years of the early-twentieth-century solar-Hijrī calendar (instituted in A.D.1925) were reckoned is 1st Farvardīn, 119 days before 1st Muḥarram of the Arabian lunar-year in which the Prophet of Islam fled from Mecca (Mikka) to Medina (Madīna). The number of days between the epoch of the Arabian Hijrī era and the epochs of other eras, either prior to or subsequent to the Hijrī era, are to be found in the writings of mediaeval Iranian historians and astronomers. Either by subtracting 119 days from, or adding 119 days to these intervals, as appropriate, the number of days between the epoch of the era of the solar-Hijrī calendar and the epochs of the other well-known eras will be as follows:

Seleucid era: 340,700 - 119 = 340,581 days (see Section II.II)

Christian era: 227,016 - 119 = 226,897 days (see Section IV.I)

Kharājī era: 4,136 - 119 = 4,017 days (see Section IV.III)

Yazdgirdī era: 3,624 - 119 = 3,505 days (see Section IV.I)

Jalālī era: 166,797 - 119 = 166,916 days (see Section IV.IV)

The corresponding Christian date of the solar-Hijrī era can be determined, either by retrogressive calculation from a date given by this calendar or by using the intervals given above, as 19th March A.D.622 (o.s.). Taqīzādeh gives 17th March A.D.622 (1), which must have been the date arrived at by the calendar-reform commission at the time of the introduction of this calendar (2).

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1. Taqīzādeh (1937), p.916; (1346 H.S.), p.180.

2. Mīrzā ʿAbd al-Ghaffār-i Munajjim of Isfahan, whose persistence led the Parliament to approve the solar-Hijrī calendar, was the first Iranian to compile comparative tables of Christian and Arabian lunar-Hijrī dates. In the introduction to his book Risāla-yi Taṭbīqīya (1321 A.H.), pp.2-10, 39, when explaining the data of Arabian and Christian calendars (old and new-style), he states that the equivalent Christian dates of lunar-Hijrī dates are given in new-style form, but he in fact gives them all in old-style form.

The months of the solar-Hijrī and Shāhanshāhī calendars are the same ancient Iranian months which first appeared in the Arsacid period and which have been used in various Iranian calendars up to the present day (see Section III.I). Although the sequence of the months and their number (twelve) are identical in all Iranian calendars (see Tables 5-7), their length was changed at the time of the introduction of the solar-Hijrī calendar (A.D.1925). The first six months now each contain 31 days; the remaining months are of 30 days, except for the twelfth month, which is of 29 days in common years and 30 days in leap years. The year begins on Nawrūz-i Jalālī, making the length of each year absolutely solar. The general view is that the regulation of the leap and common years of this calendar follows the Jalālī rule of intercalation (1), whereas in fact this is the one respect in which it is somewhat arbitrary. Taqīzādeh, who was the master-mind behind the introduction of the solar-Hijrī calendar (2), was of the opinion that the founders of the Jalālī calendar did not formulate any rule for leap and common years (3) and that "even with the modern measure of the length of the tropic year it is not possible to formulate a simple rule, applicable for a long period of time, for the intercalation of the bissextile day, because the said length is continually decreasing at a rate of 0.00000614 day each century (0.00530496 second annually)"(4). Consequently, although this calendar is astronomically the most accurate ever devised, nevertheless, since determination of the leap and common years is based on "ad hoc" calculation, reckoning the precise interval between two dates of different years is in practice not an easy task and for many people is even impossible.

Regarding the method of intercalation, three different regular cycles of intercalation have already been mentioned in this work:

1. Khāzinī's cycle of 220 years (5) by which a deviation of one day would develop between the solar year and the calendar in every 775 years (see Section IV.IV).

2. The cycle of 161 years, derived from tables of Naṣīr al-Dīn Ṭūsī and al-Simnānī, by which the difference would accumulate to one day in every 28,800 years (see Section IV.IV)(6).

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1. Taqīzādeh (1317 H.S.), p.3, n.6; Muḥīṭ Ṭabāṭabā'ī (1354 H.S.), p.16.

2. Muḥīṭ Ṭabāṭabā'ī (1354 H.S.), pp.10, 16; Gurgānī (2535 Sh.), p.35.

3. Taqīzādeh (1940-1942), p.116; (1346 H.S.), pp.203-204; cf. Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), p.685; (1354 H.S.), pp.14, 16.

4. Taqīzādeh (1317 H.S.), pp.3-4, n.9; (1940-1942), pp.116-117; (1346 H.S.), p.204; see also Rīyāḥī (1335 H.S.), p.3.

5. See Muḥīṭ Ṭabāṭabā'ī (1352 H.S.), p.685.

6. Cf. Taqīzādeh (1317 H.S.), p.173.

3. The 128-year cycle appearing in the Encyclopaedia Britannica, mathematically producing an error of one day in every 35,000 years (1).

The original Jalālī calendar used the 220-year cycle; after the establishment of the Marāgha observatory, the 161-year cycle was adopted. The third cycle is mentioned here as "food for thought" for future scholars.

All three cycles have in common the fact that the leap and common years can easily be determined by the general populace without complicated mathematical calculation (see Section IV.IV).

In Table 18, the leap years of the solar-Hijrī calendar, during the period in which this calendar was in official use (H.S.1304 to H.S.1354; A.D.1925 to A.D.1976) are given as they appeared in annual Iranian calendars of this period. The equivalent Jalālī dates and the leap years of the Jalālī calendar covering the same period are given as they appear in the Wüstenfeld-Mahler table (2); these are accompanied by those calculated by the present writer from Khāzinī's formula and also according to a formula derived from tables of Naṣīr al-Dīn and al-Simnānī.

The quinquennial Jalālī leap-years underlined in Table 18 show clearly that the solar-Hijrī leap-years do not correspond to those of Wüstenfeld-Mahler, Khāzinī and Naṣīr al-Dīn. This is the result of the non-existence of any particular rule for determining the leap and common years in this calendar. In the solar-Hijrī and Shāhanshāhī calendars, the precise instant of the vernal equinox is taken as the starting point of the new year. The same method has been adopted in the present work for the calculation of the perpetual solar-Hijrī and Shāhanshāhī calendars (see Chapter V and actual calendar in pocket inside back-cover (Appendix I)).

The Shāhanshāhī dates appearing in calendars and throughout recent Iranian publications call for special attention. Even before the official adoption of the Shāhanshāhī calendar, the equivalent dates of solar-Hijrī and Yazdgirdī dates were given in a particular category of Iranian annual calendar by a "so-called" Shāhanshāhī calendar. For example, in an annual calendar for the year H.S.1343 (A.Y.1333; A.D.1964/1965), the equivalent "Shāhanshāhī" year-date is given as 2500 (3). The difference between the solar-Hijrī and "Shāhanshāhī" dates is therefore 1157 years. Nine years later, in a similar calendar for H.S.1342 (A.Y.1342; A.D.1973/1974) the equivalent "Shāhanshāhī" date appears as 2523 (4). The difference between

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1. Encyclopaedia Britannica (11th ed.), Vol.4, pp.990-991.

2. Spuler (1961), p.39.

3. See annual calendar for year A.Y.1333, published by the Zoroastrian Institution of Tehran.

4. See annual calendar for year H.S.1352, published by Chāp-Khāna-yi Rāstī.

the eras of the two calendars is in this case 1181 years. While the difference between the equivalent solar-Hijrī, Yazdgirdī and Christian dates of the above two calendars is only the nine years it should be, there is an inordinate gap of 23 years between the two "Shāhanshāhī" dates. Furthermore, the differences between the eras of the solar-Hijrī and "Shāhanshāhī" calendars, in the above two cases, i.e. 1157 and 1181 years, both differ from the 1180 years now accepted as the exact interval between the two eras. The only possible explanation for these questionable "Shāhanshāhī" dates given by the compilers of this category of annual calendar lies in their inadequate knowledge of the nature of the unofficial (i.e. pre-1976 A.D.) "Shāhanshāhī" calendar.

In H.S.1350 (A.D.1971) the Iranians celebrated the 2500th anniversary of the foundation of the Iranian Empire. On this occasion numerous books and articles were published; the solar-Hijrī and Christian dates given in them for this particular "Shāhanshāhī" year were invariably H.S.1350 and A.D.1971. The interval between the era of the solar-Hijrī calendar and the era of the calendar by which the year of celebration is 2500 is 1150 years, i.e. 30 years less than the interval between the solar-Hijrī and the era of the official Shāhanshāhī calendar. This discrepancy is attributable to the fact that the due date of the celebration was in fact H.S.1320 (A.D. 1941), in the midst of the calamity of World War II, which prompted the Iranians to postpone the celebration until a more appropriate occasion.

CHAPTER V

Principles of date-conversion

The method of date-conversion conventionally described in astronomical handbooks usually includes explanatory material relating to all the calendars known to Iranian astronomers (1); the method of reckoning the days between the era and the date in question is followed by the conversion of the days obtained to the calendar desired. For example, to convert a Yazdgirdī date to the corresponding date in Christian time-reckoning, the elapsed complete Yazdgirdī years are multiplied by 365; the number of days up to the given date is then added to the above product, as is the number of days between the epochs of the two eras concerned. The result obtained represents the number of days between the Christian era and the date in question; this has to be converted to years, months and days. This is achieved by dividing the result by 1461 (the number of days in four old-style Christian years) and multiplying the quotient by 4; the result is the number of days from which 365 must be subtracted several times, if applicable; for each subtraction, 1 should be added to the quotient. Let us consider a worked example:

To convert 1st Farvardīn A.Y.1347 to a Christian date:

elapsed complete years	1346 x 365 =	491,290
elapsed day		1
days between eras (from Section IV.I)		230,639
		721,930

721,930 ÷ 1461 = 494 (remainder 196);

494 x 4 = 1976.

Nearest aggregate days-total to remainder is 181 (= end of June) (see Table 20);

196 - 181 = 15.

The date is therefore 15th July A.D.1977 (o.s.) or 28th July A.D.1977 (n.s.) (for relationship between old-style and new-style Christian dates, see below).

It is important not to overlook the extra year which is added to the product of 494 x 4, representing the year in which the date is located. The result of the above calculation is absolutely correct; it is not necessary to check the result against the perpetual calendars of the two systems.

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1. See, for example, Ibn Muthannā (1967), pp.17-25; Bīrūnī (1879), pp.131-134; 136-140; (1352 H.S.), pp.178-179, 183-188; Zīj-i Ilkhānī (O.2.(7)), folios 13^b-15^b; Ulugh Beg (1847), pp.305-313.

The same method of calculation can be used to convert dates from other Iranian calendars to their corresponding Christian dates by substituting the appropriate interval between the eras and the appropriate calendar-year lengths. For example, to convert a Jalālī date to the corresponding date in the Christian calendar, one has to multiply the elapsed complete Jalālī years by 365.2422 (see Section I.IV) and then add to the product the number of days between the epochs of the Christian and Jalālī eras (393,813 days)(see Section IV.IV). The days elapsed in the year up to the date concerned must then be added to this total. Thereafter, the calculation is identical to that of the above Yazdgirdī-date example.

Taking the example of the conversion of 1st Farvardīn A.J.899 to a Christian date:

elapsed complete years 898 x 365.2422 = 327,987.4956

day added for fraction 1

elapsed day 1

days between eras (from Section IV.IV) 393,812

721,801

721,801 ÷ 1461 = 494 (remainder 67);

494 x 4 = 1976.

Nearest aggregate day-total to remainder is 59 (= end of March) (see Table 20);

67 - 59 = 8.

The date is therefore 8th March A.D.1977 (o.s.) or 21st March A.D.1977 (n.s.).

In the above calculation, the length of the elapsed complete Jalālī years is taken to be the true length of the solar year, as it also is in the solar-Hijrī and Shāhanshāhī calendars (see Section IV.VI). To convert from the solar-Hijrī calendar to a Christian date, the number of days between the Christian era and the era of the solar-Hijrī calendar should be substituted in the above Jalālī example. A worked example of 1st Farvardīn S.H.1356, which is the date corresponding to 1st Farvardīn A.J.899, is given below:

elapsed complete years 1355 x 365.2422 = 494,903.181

elapsed day 1

days between eras (from Section IV.VI) 226,896

721,801

721,801 ÷ 1461 = 494 (remainder 67);

494 x 4 = 1976.

Nearest aggregate day-total to remainder is 59 (= end of February) (see Table 20);

67 - 59 = 8.

The date is therefore 8th March A.D.1977 (o.s.) or 21st March A.D.1977 (n.s.).

In the above example of the solar-Hijrī calendar, it was important to take the number of days between the epochs of the Christian and solar-Hijrī eras as 393,812, rather than 393,813, the actual number of days between the two eras. The same applies to the number of days between the epochs of the Christian and Jalālī eras which must be taken as 226,896, instead of the actual number of 226,897 days. The reason for this is that, because in the multiplication of the elapsed complete years of the solar-Hijrī and Jalālī calendar by the length of the true solar year there is always a fraction of a day, when this is greater than the day-fraction in one true solar year (0.2422), it has to be taken as one complete day in date-conversion between the above two calendars.

The Christian dates arrived at in the two above examples are Julian, i.e. "old-style"; after 4th October A.D.1582, when the Julian calendar was modified according to the reform instituted by Pope Gregory XIII (1), 10 days must be added to the Julian month-date to find the Gregorian equivalent; this rule applies up to A.D.1699, whereafter the difference between Julian and Gregorian dates is 11 days between 1700 and 1799 (inclusive); 12 days from 1800 to 1899; 13 days for the period 1900 to 2099.

The involved, and thereby confusing, method of reckoning the year immediately before an era as year 0, which is usually adopted by astronomers (2), has never been employed by mediaeval Iranian astronomers in giving the intervals between the epochs of different eras, either for date-conversion or perpetual calendars. This has misled certain modern authors with regard to the conversion of Seleucid-era dates given by mediaeval Iranian historians and astronomers (see Section II.III).

The method given by Iranian astronomers (3) for the conversion of lunar-Hijrī and solar-Hijrī dates to a Seleucid form is as follows:

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1. There is extensive literature relating to the reform of the Christian calendar: e.g. Nicolas (1833), pp.32-36; Cheney (1970), pp.10-11.

2. See Almagest (1952), p.467; Bickerman (1969), p.90.

3. See Humā'ī (1340 H.S.), pp.436-439, 444-445.

For example, to convert the lunar-Hijrī 1st Rabī'II A.H.1397 to a Seleucid date:

elapsed complete years 1396 x 354.3670 = 494,696.332

elapsed days 89 + 1 = 90

days between eras (from Section II.III) 340,699

835,485

835,485 ÷ 1461 = 571 (remainder 1254);

571 x 4 = 2284;

1254 - (3 x 365) = 159.

Nearest aggregate day-total to remainder is 151 (= end of Shubat) (see Table 20);

159 - 151 = 8.

The date is therefore 8th Adar S.E.2288.

Taking an example of the conversion of the solar-Hijrī 1st Farvardīn S.H.1356 to a Seleucid date:

elapsed complete years 1355 x 365.2422 = 494,903.131

elapsed day 1

days between eras (from Section IV.VI) 340,580

835,484.131

835,484 ÷ 1461 = 571 (remainder 1253);

571 x 4 = 2284;

1253 - (3 x 365) = 158.

Nearest aggregate day-total to remainder is 151 (= end of Shubat);

158 - 151 = 7.

The day of 1st Farvardīn in S.H.1356 is a Monday (see perpetual calendar - Appendix I), whereas 7th Adar S.E.2288 is a Sunday; because of the slight built-in error resulting from the fraction and the leap-year differences, the above calculation has to be corrected by adding one day to 7th Adar to produce the correct date of 8th Adar S.E.2288.

It is important to know that the year S.E.2288 is not a leap year: to determine leap years in the Seleucid calendar, the year in question must be divided by 4; only if the remainder is 3, is the year a leap year.

Seleucid dates can naturally be converted to their equivalent solar-Hijrī or lunar-Hijrī dates by reversing the above procedures.

For example, to convert 8th Adar S.E.2288 to a solar-Hijrī date:

elapsed complete years	2287 x 365.25	= 835,326.75
elapsed days	151 + 8	= 159
		835,485.75
days between eras		-340,580

494,905.75 ÷ 365.2422 = 1355 (remainder 2).

According to the relevant perpetual calendars, the result of the above calculation must be corrected by one day; the corresponding solar-Hijrī date of 8th Adar S.E.2288 will be 1st Farvardīn S.H.1356.

The same method of calculation may be employed for any other calendar discussed in the present work, except the Babylonian and Macedonian lunisolar calendars, for which an already perfect comparative table has been produced by Parker and Dubberstein (1). These co-authors have admitted that there is sometimes a discrepancy of one day between the Babylonian dates and their equivalents (2). The above calculation is also accurate to within one day, which can be corrected by checking the result against perpetual calendars. The discrepancy arises from the variety of methods employed to regulate the leap and common years in different calendars and even in the same calendar in different centuries. Furthermore, since the nychthemeron does not correspond precisely in different calendars, it is quite possible for a one-day discrepancy to appear in the conversion of different calendar-dates. For this reason it is always advisable to check the result of calculation against a perpetual calendar. It is, incidentally, also simpler to use the above method of calculation, subject to this perpetual-calendar check, than to produce massive conversion tables for the purpose.

There are several other methods for date-conversion, all of which are fundamentally identical (3), but all require that the result of calculation be checked against a perpetual calendar to effect the requisite one-day, and occasionally two-day correction.

Among the many perpetual calendars, either described or tabulated in mediaeval astronomical works, modern handbooks of dates, or relevant articles (4), the two perpetual calendars for Christian and

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1. Parker and Dubberstein (1946), pp.25 ff.

2. Parker and Dubberstein (1946), p.23; see also Wiseman (1960), pp.74-75.

3. See Ulugh Beg (1847), pp.311-313; also Janāb (1303 H.S.), pp.90-103; Rīyāḥī (1335 H.S.), pp.4-32; Mammadbeyli (1972), pp.47-84.

4. See Humā'ī (1340), pp.419-447; Rīyāḥī (1335 H.S.), pp.6-8, 12-14, 20-21; Abdollahy (1352 H.S.), pp.728-739; Abdollahy and Dergregorian (1352 H.S.), pp.747-762.

solar-Hijrī dates, produced in connection with the present work (see Appendices I and II), appear to be the easiest to use for checking the results of date-conversions between the above-mentioned calendars.

The perpetual Jalālī calendar, which has not been included, is identical to the solar-Hijrī calendar, apart from the year-date, for which one has to subtract 457 (see Table 18) from any date of the solar-Hijrī calendar to determine the corresponding Jalālī year-date. In the perpetual solar-Hijrī calendar, the year H.S.458 may be taken as year 1 of the Jalālī calendar (see above), as is the common practice among historians, there being in this instance no year 0 for the era of the Jalālī calendar.

The perpetual lunar-Hijrī calendar has been reproduced in simple form as Table 21 since it is the subject of a previous publication by the present writer (1); those requiring guidance in its use are referred to that article.

The format of the appended perpetual Christian and solar-Hijrī calendars is identical apart from the different periods of application.

The numbers 1 to 99 at the periphery of the lower disc, which are visible through the cut-out in the upper disc, when combined with the century-numbers, which in the Christian version appear on both sides of a window in the upper disc, produce Gregorian or Julian dates up to 2400 A.D. Similarly, in the perpetual solar-Hijrī and Shāhanshāhī calendars, the similarly arranged numbers 1 to 99 have to be combined with 1300. For a date in the Shāhanshāhī calendar, 1180 years must be added to the solar-Hijrī date.

Leap years in the Christian calendar are indicated by "boxes". If the year in question is a leap year and the month is either January or February, the appropriate "boxed" month should be aligned with the year-panel. In the solar-Hijrī calendar the leap years are in parentheses, but require no special treatment (the leap years are marked to indicate that the month Isfand has 30 rather than 29 days in that year).

The days of the week in the perpetual Christian calendar appear in seven continuous annular panels on the lower disc and are visible through a cut-out in the upper disc. Each annular panel appertains to the centuries marked on either side of the window in the upper disc, qualified as Gregorian and Julian. If a date in question is in Julian form, the peripheral two-digit numbers on the lower disc should be combined with the centuries in the Julian column; Gregorian dates must be treated accordingly.

The numbers appearing in the seven columns at the lower edge of the upper disc represent the days of the months.

With regard to the actual use of the perpetual Christian and solar-Hijrī/Shāhanshāhī calendars, the procedure is as follows:

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1. Abdollahy (1352 H.S.), pp.728-739.

To find the day of the week, when the year, month and month-day of a Christian date are known, the discs should be manipulated until the upper month-panel containing the name of the month concerned is opposite the year-panel containing the number of the year in question. Note should then be taken of the annular section of the week-days "window" opposite the segment-section for the appropriate century. The day of the week is determined by the point of intersection of the radial column through the peripheral segment including the day of the month in question and the "century ring".

For example, to determine the day of the week of 23rd May 1977:

Set the May panel opposite the panel including the number 77. The weekdays "ring" corresponding to 1900/1500/2300 will then show Monday as being in line with 23 in the peripheral panel. 23rd May 1977 is therefore a Monday.

The absolute accuracy of the tables in determining the day of the week is unfortunately not matched in other directions, due to the multiple choice of month-day, month, year and century. However, taken in conjunction with other evidence, the perpetual table can often be of assistance in determining a missing component of a date, provided three of the four are known.

Table 1. Comparative list of names of days of month as used in the Avesta, by Bīrūnī, and in the modern Zoroastrian calendar.

No.	Avesta	Bīrūnī	Present Zoroastrian
1	Ahuramazda (1)	Hurmuz (Farrukh)(2)	Hurmazd (3)
2	Vūhumana	Bahman	Bahman
3	Ashavāhīshta	Ūrdībihisht	Ūrdībihisht
4	Khshthravavaīya	Sharīwar	Shahrīvar
5	Spintaārmaiti	Isfandārmadh	Ispandārmadh (Isfand)
6	Haurrvatāt	Khurdādh	Khūrdād
7	Amiritāt	Murdādh	Amūrdād (Murdad)
8	Din-pa-Ātar	Dai-ba-Ādhar	Dai-bi-Ādhar
9	Ātar	Ādhar	Ādhar
10	Āpan	Ābān	Ābān
11	Hvarkhaita	Khūr	Khūrshid (Khūr)
12	Maūngh	Māh	Māh
13	Tīshtshrya	Tīr	Tīr
14	Giush	Gūsh	Gūsh
15	Dīn-pa-Mithra	Daī-ba-Mihr	Daī-bi-Mihr
16	Mithra	Mihr	Mihr
17	Sraūsha	Surūsh	Surūsh
18	Rashnu	Rashn	Rashn
19	Faravashī	Farwardīn	Farvardīn
20	Virithraghna	Bahram	Bahrām
21	Rām	Rām	Rām
22	Vāta	Bādh	Bād
23	Dīn-pa-Daina	Dai-ba-Dīn	Dai-bi-Dīn
24	Daina	Dīn	Dīn
25	Ashī	Ard	Ard (Art)
26	Arshtāt	Ashtādh	Ashtād
27	Asman	Āsmān	Āsimān
28	Zamyāt	Zamyādh	Zamyāt
29	Mantharaspīnta	Mārsfand	Mārispand (Mihispand)
30	Anaghra	Anīrān (Bihrūz)	Anīrān

1. The writer is indebted to Dr. J. Doostkhah of the University of Isfahan for his assistance in reading the Avestan day-names in their original form. See also Spiegel (1864), Khurda-Avesta, pp.145-152; Darmesteter (1883), pp.1-20; Doostkhah (1343 H.S.), pp.340-348.

2. Bīrūnī (1879), p.53; (1352 H.S.), p.69; (1934), pp.170-189; (1316-1318 H.S.), pp.234, 278.

3. Sālnāma-yi 1333 Yazdgirdī (published for the Zoroastrian Institution of Iran); see also chapter III.

Table 2. Sequences of Old-Persian months derived over the past two centuries.

No.	Rawlinson (1)	Oppert (1)	Unger (1, 2)	Justi (3)	Prašek (1, 2, 3, 4)	Cameron (5)
1	Bāgayādī	Garmapada	Thūravāhara	Thūravāhara	.....	Ādukananisha
2	Thūravāhara	Thūravāhara	Thāigarci	Thāigarci	Thūravāhara	Thūravāhara
3	Thāigarci	Thāigarci	Adukani	Adukani	Thāigarci	Thāigarci
4	Adukani	.....	Margazana	.....	Garmapada	Garmapada
5	Garmapada	.....	Garmapada	Garmapada	.....	Darnabāji
6	.....	.....	.....	.....	.....	.....
7	.....	Bāgayādī	Bāgayādī	Bāgayādī	Bāgayādī	Bāgayādī
8	Margazana	Adukani	.....	.....	Adukani	Varkazana
9	Āthriyādiya	Āthriyādiya	Āthriyādiya	Āthriyādiya	Āthriyādia	Āthriyadiya
10	Anāmaka	Anāmaka	Anāmaka	Anāmaka	Anāmaka	Anāmaka
11	.....	Margazana	.....	Margazana	Margazana	.....
12	Viyakhna	Viyakhna	Viyakhna	Viyakhna	Viyakhna	Viyakhna

1. Ginzel (1906), p.276.
2. Gray (1910), p.128
3. Justi (1925), p.239, n.1.
4. See Taqīzādeh (1316 H.S.), pp.112-114.
5. Cameron (1948), pp.44-45.

Table 3. Sequence of Old-Persian, Elamite, Jewish and Babylonian months (1)

No.	Old-Persian	Achaemenid-Elamite	Jewish	Babylonian	Equivalent Julian
1	Adukanīsh	Hadukannash	Nisan	Nisanu	March-April
2	Thuravahara	Turmar	Iyyar	Aiaru	April-May
3	Thāigarchīsh	Sakurrīsīsh	Sīvan	Simanu	May-June
4	Garmapada	Karmabadash	Tammuz	Duzu	June-July
5	.....	Turnabasish	Āb	Abu	July-Aug
6	.....	Qarbashiyash	Elul	Ululu	Aug-Sept
7	Bāgayādīsh	Bagiyatish	Tishrī	Tashritu	Sept-Oct
8	Varkazana	Marqashanash	Heshvan	Arahsamnu	Oct-Nov
9	Asiyadiya	Hashīyatish	Kislev	Kislimu	Nov-Dec
10	Anāmaka	Hanamakash	Tebeth	Tebetu	Dec-Jan
11	.....	Samimash	Shebat	Shabatu	Jan-Feb
12	Viyakhna	Mikannash	Adar	Addaru	Feb-March

1. Parker and Dubberstein (1946), p.24; Kent (1953), p.161.

Table 4. Macedonian and Syrian month-names with their approximate Julian equivalents (1).

No.	Macedonian	Julian	Syrian	Julian
1	Dios	(Sept-Oct)	Tishrin	October
2	Apellaios	(Oct-Nov)	Tishrin II	November
3	Audynaios	(Nov-Dec)	Kanun	December
4	Peritios	(Dec-Jan)	Kanun II	January
5	Dystros	(Jan-Feb)	Shubat	February
6	Xanthikos	(Feb-Mar)	Adar	March
7	Artemisios	(Mar-Apr)	Nisan	April
8	Daisios	(Apr-May)	Ayyar	May
9	Panemos	(May-June)	Haziran	June
10	Loös	(June-July)	Tammuz	July
11	Gorpiaios	(July-Aug)	Ab	August
12	Hyperberelaios	(Aug-Sept)	Elul	September

1. See Bīrūnī (1879), pp.70, 83, 231-267, 282-298, 314-321; Naṣīr al-Dīn Ṭūsī (O.2.(7)), fol.12[a]; also Ḥākimī, Gāhshumārī-yi Rūmī va Adab-i Fārsī, M.D.A., Vol.15, 1346 H.S., pp.291-299; Parker and Dubberstein (1946), p.24; Dean (1943), p.136.

Table 5. Position of the five supplementary days (Epagomenae) in relation to the Zoroastrian months during the first eight intercalation cycles.

First cycle 378-258 B.C.	Last year of first cycle 258 B.C.	Second cycle 257-138 B.C.	Last year of second cycle 138 B.C.
Farvardīn	Farvardīn	Farvardīn	Farvardīn
Urdībihisht	Urdībihsht	Epagomenae	Intercalary month
Khurdād	Khurdād	Urdībihist	Epagomenae
Tīr	Tīr	Khurdād	Urdībihisht
Murdād	Murdād	Tīr	Khurdād
Shahrīvar	Shahrīvar	Murdād	Tīr
Mihr	Mihr	Shahrīvar	Murdād
Ābān	Ābān	Mihr	Shahrīvar
Ādhar	Ādhar	Ābān	Mihr
Daī	Daī	Ādhar	Ābān
Bahman	Bahman	Daī	Ādhar
Isfandārmadh	Isfandārmadh	Bahman	Daī
Epagomemae	Intercalary month	Isfandārmadh	Bahman
	Epagomenae		Isfandārmadh

Table 5 (continued)

Third cycle 137-18 B.C.	Last year of third cycle 18 B.C.	Fourth cycle 17 B.C.-A.D.101	Last year of fourth cycle A.D.101
Farvardīn	Farvardīn	Farvardīn	Farvardīn
Urdībihisht	Urdībihisht	Urdībihisht	Urdībihisht
Epagomenae	Intercalary month	Khurdād	Khurdād
Khurdād	Epagomenae	Epagomenae	Intercalary month
Tīr	Khurdād	Tīr	Epagomenae
Murdād	Tīr	Murdād	Tīr
Shahrīvar	Murdād	Shahrīvar	Murdād
Mihr	Shahrīvar	Mihr	Shahrīvar
Ābān	Mihr	Ābān	Mihr
Ādhar	Ābān	Ādhar	Ābān
Daī	Ādhar	Daī	Ādhar
Bahman	Daī	Bahman	Daī
Isfandārmadh	Bahman	Isfandārmadh	Bahman
	Isfandārmadh		Isfandārmadh

Table 5 (continued)

Fifth cycle A.D.102-221	Last year of fifth cycle A.D.221	Sixth cycle A.D.222-341	Last year of sixth cycle A.D.341
Farvardīn	Farvardīn	Farvardīn	Farvardīn
Urdībihisht	Urdībihisht	Urdībihisht	Urdībihisht
Khurdād	Khurdād	Khurdād	Khurdād
Tīr	Tīr	Tīr	Tīr
Epagomenae	Intercalary month	Murdād	Murdād
Murdād	Epagomenae	Epagomenae	Intercalary month
Shahrīvar	Murdād	Shahrīvar	Epagomenae
Mihr	Shahrīvar	Mihr	Shahrīvar
Ābān	Mihr	Ābān	Mihr
Ādhar	Ābān	Ādhar	Ābān
Daī	Ādhar	Daī	Ādhar
Bahman	Daī	Bahman	Daī
Isfandārmadh	Bahman	Isfandārmadh	Bahman
	Isfandārmadh		Isfandārmadh

Table 5 (continued)

Seventh cycle A.D.342-461	Last year of seventh cycle A.D.461	Eighth and ninth cycles A.D.462-....
Farvardīn	Farvardīn	Farvardīn
Urdībihisht	Urdībihisht	Urdībihisht
Khurdād	Khurdād	Khurdād
Tīr	Tīr	Tīr
Murdād	Murdād	Murdād
Shahrīvar	Shahrīvar	Shahrīvar
Epagomenae	Intercalary month	Mihr
Mihr	Intercalary month	Ābān
Ābān	Epagomenae	Epagomenae
Ādhar	Mihr	Ādhar
Daī	Ābān	Daī
Bahman	Ādhar	Bahman
Isfandārmadh	Daī	Isfandārmadh
	Bahman	
	Isfandārmadh	

Table 6. Corresponding Julian dates for the Vahījakīk and modified calendar-months (Kharājī) for the year A.D.632 (Yazdgirdī era).

Vahījakīk		Julian	Kharājī	
1	Farvardīn (Nawrūz)	17 Feb - 17 March	9	Ādhar (Bahar Jashn)
2	Urdībihisht	18 March - 16 April	10	Daī
3	Khurdād	17 April - 16 May	11	Bahman
4	Tīr	17 May - 15 June	12	Isfandārmadh
5	Murdād (Amurdād)	16 June - 15 July	1	Farvardīn (Nawrūz)
6	Shahrīvar	16 July - 14 Aug	2	Urdībihisht
7	Mihr	15 Aug - 13 Sept	3	Khurdād
8	Ābān	14 Sept - 13 Oct	4	Tīr
9	Ādhar	14 Oct - 12 Nov	5	Murdād (Amurdād)
10	Daī	13 Nov - 12 Dec	6	Shahrīvar
11	Bahman	13 Dec - 11 Jan	7	Mihr
		A.D.633		
12	Isfandārmadh	12 Jan - 10 Feb	8	Ābān
	Epagomenae	11 Feb - 15 Feb		Epagomenae

Table 7. Corresponding Julian-calendar periods of the Vahījakīk and Kharājī months for the year A.D.462 (the year subsequent to the adjustment and simultaneous two-month intercalation).

Vahījakīk		Julian	Kharājī	
1	Farvardīn (Nawrūz)	1 March - 30 March	9	Ādhar (Bahar Jashn)
2	Urdībihisht	31 March - 29 April	10	Daī
3	Khurdād	30 April - 29 May	11	Bahman
4	Tīr	30 May - 28 June	12	Isfandārmadh
5	Murdād (Amurdad)	29 June - 28 July	1	Farvardīn (Nawrūz)
6	Shahrīvar	29 July - 27 Aug	2	Urdībihisht
7	Mihr	28 Aug - 26 Sept	3	Khurdād
8	Ābān	27 Sept - 26 Oct	4	Tīr
9	Ādhar	27 Oct - 25 Nov	5	Murdād (Amurdad)
10	Daī	26 Nov - 25 Dec	6	Shahrīvar
11	Bahman	26 Dec - 24 Jan	7	Mihr
		A.D.463		
12	Isfandārmadh	25 Jan - 23 Feb	8	Ābān
	Epagomenae	24 Feb - 28 Feb		Epagomenae

Table 8. Corresponding Julian dates for New Year's Day (Nawrūz) of the Kharājī (modified) Zoroastrian calendar for the period A.D.462 to A.D.892 (1).

A.D.		A.D.		A.D.		A.D.		A.D.		A.D.		A.D.		A.D.	
462	July 29	516	15	572	1	620	19	676	5	728	23	784	9	840	25
464	28	520	14		June	624	18	680	4	732	22	792	8	844	24
468	27	524	13	576	30	628	17	684	3	736	21	796	6	848	23
472	26	528	12	580	29	632	16 (3)	688	2	740	20	800	5	852	22
476	25	532	11	584	28	636	15	692	1	744	19	804	4	856	21
480	24	536	10	588	27	640	14		May	748	18	808	3	860	20
484	23	540	9	592	26	644	13	696	31	752	17	812	2	864	19
488	22	544	8	596	25	648	12	700	30	756	16	816	1	868	18
492	21	548	7	600	24	652	11 (4)	704	29	760	15		April	872	17
496	20	552	6	604	23	656	10	708	28	764	14	820	30	876	16
500	19	556	5	608	22	660	9	712	27	768	13	824	29	880	15
504	18	560	4	611 (2)	22	664	8	716	26	772	12	828	28	884	14
508	17	564	3	612	21	668	7	720	25	776	11	832	27	888	13
512	16	568	2	616	20	672	6	724	24	780	10	836	26	892	12

1. The Kharājī calendar during this period consisted of twelve months, each of thirty days, with five supplementary days added between the eighth and ninth months (i.e. Ābān and Ādhar). The year was 365 days without intercalation. During the period covered by the table (A.D.462 to A.D.892), whenever a leap year occurred in the Julian calendar, the beginning of the Kharājī calendar retrogressed one day in relation to the Julian. Since the Kharājī New Year's Day was always in a month after February (the Julian month in which the leap-day was inserted), the number of the month-day of the Julian calendar will be one day less in a leap year, and not in the subsequent year, as it is in the present Iranian calendar whenever the leap years of the two calendars do not fall in the same Christian year.

2. The year A.D.611 is the era of the Kharājī calendar, as reckoned by Iranian authors of later centuries (see Section IV.III).

3. The epoch of the Yazdgirdī era is 16th June A.D.632 (see Section IV.I).

4. The epoch of the Magian era (Fārsīya) is 11th June A.D.652 (see Section IV.II).

Table 9. The Zoroastrian Gāhanbārs as they appear in the Avesta and Bundahishn.

	Gāhanbār	Feast-days	Zoroastrian months	Equivalent Julian periods
1	Maidhyūizarimaya 1st Farvardīn to 15th Urdībihist (45 days)	11th to 15th Urd.	Farvardīn	Mar - April
			Urdībihisht	April - May
2	Maidhyūishima 16th Urdībihisht to 15th Tīr (60 days)	11th to 15th Tīr	Khurdād	May - June
			Tīr	June - July
3	Paitishhahya 16th Tīr to 30th Shahrīvar (75 days)	26th to 30th Shahrīvar	Murdād	July - Aug
			Shahrīvar	Aug - Sep
4	Ayāthrim 1st Mihr to 30th Mihr (30 days)	26th to 30th Mihr	Mihr	Sep - Oct
5	Maidhyāirya 1st Ābān to 20th Daī (80 days)	16th to 20th Daī	Ābān	Oct - Nov
			Ādhar	Nov - Dec
			Daī	Dec - Jan
6	Hamaspathmaīdhya 21st Daī to fifth epagomenal day (75 days)	1st to 5th epagomenae	Bahman	Jan - Dec
			Isfandārmadh	Feb - Jan
			Epagomenae	March

Table 10. The Zoroastrian Gāhanbārs as they appear in Bīrūnī's work.

	Gāhanbār	Feast-days	Zoroastrian months	Equivalent Julian periods
1	Maidhyūizarimaya 1st Ādhar to 15th Daī (45 days)	11th to 15th Daī	Ādhar (1)	Mar - April
			Daī	April - May
2	Maidhyūishima 16th Daī to 15th Isfand. (60 days)	11th to 15th Isfand.	Bahman	May - June
			Isfandārmadh	June - July
3	Paitishhahya 16th Isfand. to 30th Urdībihisht (75 days)	26th to 30th Urdībihisht	Farvardīn	July - Aug
			Urdībihisht	Aug - Sept
4	Ayāthrima 1st to 30th Kurdād (30 days)	26th to 30th Khurdād	Kurdād	Sept - Oct
5	Maidhyāirya 1st Tīr to 20th Shahrīvar (80 days)	16th to 20th Shahrīvar	Tīr	Oct - Nov
			Murdād	Nov - Dec
			Shahrīvar	Dec - Jan
6	Hamaspathmaīdhya 21st Shahrīvar to fifth epagomenal day (75 days)	1st to 5th epagomenae	Mihr	Jan - Feb
			Ābān	Feb - Mar
			Epagomenae	March

1. Although Ādhar was included in the modified calendar, it has never been used as the first month of the calendar year (see pp. 108 ff).

Table 11. Kharājī and corresponding lunar-Hijrī dates after various authors. The equivalent Christian, solar-Hijrī and Yazdgirdī dates, calculated indirectly from the lunar-Hijrī dates in column 2, have only been given for precise (i.e. three-element) dates. (Corresponding Jalālī dates for column 4 equal the Solar-Hijrī shown, minus 457 years).

No	Kharājī	Lunar-Hijrī	Christian	Solar-Hijrī	Yazdgirdī
1	468 1st Far.	471 9th Ram.	1079 15th Mar.	458 1st Far.	448 19th Far.(
2	544 19th Far.	511 16th Jum.I (2)	1156 6th July	535 26th Tīr	525 1st Shar.
3	558 Isfand.	566 (3)			
4	562	569 (4)			
5	566 Urd.	572 1st Ram. (5)	1177 3rd Mar.	555 25th Isfand.	546 1st Urd.
6	572 1st Tīr	579 (6)			
7	573	580 (7)			
8	574	581 (8)			
9	577 Tīr	585 (9)			
10	586 Khur.	592 (10)			
11	594 Khur.	600 1st Ram. (11)	1204 3rd May	583 11th Urd.	573 9th Tīr
12	24th Khur.	600 3rd Shaw. (12)			
13	595 15th Khur.	601 7th Ram. (13)	1205 28th April	584 16th Urd.	574 4th Tīr
14	597 2nd Bah.	604 Jam.II (14)			
15	692 1st Far.	701 12th Raj. (15)	1302 13th Mar.	681 1st Far.	672 12th Khur.
16	693 13th Khur.	702 23rd Raj. (16)	1303 14th Mar.	682 1st Far.	673 13th Khur.

1. See Section IV.IV. 2. Muḥammad b. Ibrāhīm (1886, Persian Text), p.34. 3. Ibid, p.48. 4. Ibid, p.65. 5. Ibid, p.92.

6. Ibid, p.121; the Kharājī month-day is given by the Zoroastrian name Hurmazd.

7. Ibid, p.124. 8. Ibid, p.130. 9. Ibid, p.150.

10. Ibid, p.167. 11. Ibid, p.192. 12. Ibid, p.195.

13. Ibid, p.196; although the date given above is not qualified by the word Kharājī, it is certain that this date is of the same nature as those given by the author of Saljūq-nāma. The thirteenth date in the above table, obtained from Saljūq-nāma, also appears in Lughatnāma under the entry for "Kharājī", but unfortunately most of the dates in this encyclopaedia have been incorrectly copied.

14. Zīj-i Mufrad (O.1.(10)), fol.77; see also Taqīzādeh (1937), pp.911-912; (1346 H.S.), p.173.

15. Waṣṣaf, apud Taqīzādeh (1937), p.912; (1346 H.S.), p.173.

16. Zīj-i Ashrafī (Paris 1488), folios 10^b-11^a.

Table 12. The Jalālī month-names.

1	Māh-i Naw
2	Māh-i Nawbahār
3	Māh-i Garmāfazā (1)
4	Māh-i Rūzafzūn
5	Māh-i Jahāntāb
6	Māh-i Jahānārā(y)
7	Māh-i Mihrgān
8	Māh-i Khazān
9	Māh-i Sarmāfazā (2)
10	Māh-i Shabafzūn
11	Māh-i Atashafrūz
12	Māh-i Sālafzūn (3)

1. This month appears in Zīj-i Ashrafī ((Paris 1488), fol. 4^a) in the form Māh-i Garmāfazāy.

2. The form given in the above MS. of Zīj-i Ashrafī is Māh-i Sarmāfazāy.

3. The name of the twelfth month figures in Sī-faṣl ((1330 A.H.), faṣl 6th) as Māh-i Rūzafzūn, which is a repetition of the fourth month. The author of Zīj-i Ashrafī gives the name of the twelfth month in the form given in the table, whose validity is confirmed by the very meaning of the name ("the month at the end of which the year will be one more"), whereas the fourth month may be interpreted as "the month in which the day becomes longer than the night".

Table 13. The Jalālī day-names (1).

1	Jashnsāz	19	Gūybāz
2	Bazmmih	20	Pāydār
3	Sarfarāz	21	Mihrkār
4	Kashnishīn	22	Dūstbin
5	Nūshkhūr	23	Jānfazā(y)
6	Ghamzadā(y)	24	Butfarīb
7	Rukhfurūz	25	Kāmrān
8	Mālbakhsh	26	Shādbāsh
9	Zarfashān	27	Dīrzī
10	Nāmjū(y)	28	Shīrgīr
11	Razmjū(y)	29	Kāmyāb
12	Kīnakish	30	Ayshahrīyār
13	Tīghzan	Epagomenae	
14	Dāddih	1	Āfarīn
15	Dīnpizhūh	2	Farrukh
16	Dīvband	3	Fīrūz
17	Rahgushā(y)	4	Rāmisht
18	Asbtāz	5	Durust

1. See Sī-faṣl (1330 A.H.), Faṣl 6th; Zīj-i Ashrafī (Paris 1488), fol.4[a].

Table 14. Quadrennial and quinquennial Jalālī leap-years, calculated according to Khāzinī's formula for the first 1028 Jalālī years.

3	65	127	190*	252	314	376	439	501	567	634	700	767*	833	899	966
7	69	132*	194	256	318	381*	443	505	572*	638	704	771	837	904*	970
11	73	136	198	260	322	385	447	509	576	642	708	775	841	908	974
15	78*	140	202	264	327*	389	451	513	580	646	713*	779	845	912	978
19	82	144	206	268	331	393	455	518*	584	650	717	783	850*	916	982
24*	86	148	210	273*	335	397	459	522	588	655*	721	787	854	920	987*
28	90	152	215*	277	339	401	464*	526	592	659	725	792*	858	924	991
32	94	156	219	281	343	405	468	530	596	663	729	796	862	928	995
36	98	161*	223	285	347	410*	472	534	601*	667	733	800	866	933*	999
40	102	165	227	289	352*	414	476	538	605	671	738*	804	870	937	1003
44	107*	169	231	293	356	418	480	542	609	675	742	808	875*	941	1007
48	111	173	235	298*	360	422	484	547*	613	679	746	812	879	945	1012*
53*	115	177	239	302	364	426	488	551	617	684*	750	816	883	949	1016
57	119	181	244*	306	368	430	493*	555	621	688	754	821*	887	953	1020
61	123	185	248	310	372	435*	497	559	625	692	758	825	891	958*	1024
								563	630*	696	762	829	895	962	1028

Table 15. The Jalālī leap-years as they appear in Zīj-i Ilkhānī. (The sets of three rows represent Abjad-alphabet numerals, English transliterations and equivalent Arabic numerals.)

Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.
كـ	و	ع	ه	ط	د	ـى	ح	و	ـ	ـ	ا
KB	W	YḤ	H	YD	D	Y	J	W	B	B	A
22	6	18	5	14	4	10	3	6	2	2	1
مـ	سـ	ص	ن	ظ	ـى	ل	ط	ك	ح	كـ	ر
MZ	YB	MJ	YA	LṬ	Y	LH	Ṭ	LA	Ḥ	KW	Z
47	12	43	11	39	10	35	9	31	8	26	7
عـ	خ	ح	ز	سـ	هـ	نـ	ـمـ	فـ	مـ	نـ	ـحـ
ʿB	YḤ	SḤ	YZ	SD	YW	NṬ	YH	NH	YD	NA	YJ
72	18	68	17	64	16	59	15	55	14	51	13
صـ	كـ	صـ	ـحـ	ـمـ	كـ	ـهـ	ـكـ	ف	ى	عـ	ط
ṢZ	KD	ṢB	KJ	FḤ	KB	FH	KA	F	K	ʿW	YṬ
97	24	92	23	88	22	84	21	80	20	76	19
قـا	ل	قـ	كـ	سـ	كـ	نـ	كـ	قـ	ى	تـ	كـ
QKA	L	QYZ	KṬ	QYJ	KḤ	QṬ	KZ	QH	KW	QA	KH
121	30	117	29	113	28	109	27	105	26	101	25
مـو	لـو	مـ	لـ	ـلـ	لـ	ـلـ	لـ	قل	لـ	ـكـ	كا
QMW	LW	QMB	LH	QLH	LD	QLD	LJ	QL	LB	QKH	LA
146	36	142	35	138	34	134	33	130	32	125	31

Table 15 (continued)

ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
37	150	38	154	39	158	40	163	41	167	42	171
ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
43	175	44	179	45	183	46	187	47	192	48	196
ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
49	200	50	204	51	208	52	212	53	216	54	220
ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
55	225	56	229	57	233	58	237	59	241	60	245
ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
61	249	62	253	63	258	64	262	65	266	66	270
ر	ق	ل	ن	ك	م	خ	ف	ص	ش	ع	ه
R	QN	LZ	NH	K	M	KH	F	S	SH	‘	H
67	274	68	278	69	282	70	286	71	291	72	295

Table 16. Al Simnānī's table of Jalālī leap-years (Tawḍīḥ-i Zīj-i Ilkhānī, fol. 6[a]), from the 73rd leap-year onwards (for earlier Jalālī leap-years, see Table 15).

Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.	Leap year	No.
سک	ع	سد	ء	سا	ءو	سز	ه	سج	ءد	رصط	ءج
ShK	ʿH	ShYH	ʿZ	ShYA	ʿW	ShZ	ʿH	ShJ	ʿD	RṢṬ	ʿJ
320	78	315	77	311	76	307	75	303	74	299	73
سمد	مد	سلم	ءز	سلو	مب	سلب	ما	سلح	ف	سکد	عط
ShMD	FD	ShLM	FJ	ShLW	FB	ShLB	FA	ShKḤ	F	ShKD	ʿṬ
344	84	340	83	336	82	332	81	328	80	324	79
مشط	ص	مسه	مط	مسا	مح	مسز	مو	مسج	مد	مسح	مه
ShṢṬ	Ṣ	ShSH	FṬ	ShSA	FḤ	ShNZ	FZ	ShNJ	FW	ShMH	FH
369	90	365	89	361	88	357	87	353	86	348	85
صصد	صو	صص	صه	صسو	صد	صسا	صز	صسر	صد	صسح	ص
ShṢD	ṢW	ShṢ	ṢH	ShFW	ṢD	ShFA	ṢJ	ShẒ	SB	ShJ	SA
394	96	390	95	386	94	381	93	377	92	373	91
ضط	ضب	ضد	ضا	ضی	ضں	ضو	ضط	ضت	ضح	ضع	ضر
TYṬ	QB	TYD	QA	TY	Q	TW	ṢṬ	TB	SH	ShSḤ	SZ
419	102	414	101	410	100	406	99	402	98	398	97
طمج	طح	طلط	طر	طله	طو	طلا	طه	طتر	طد	طتج	طج
TMJ	QḤ	TLṬ	QZ	TLH	QW	TLA	QH	TKZ	QD	TKJ	QJ
443	108	439	107	435	106	431	105	427	104	423	103

Table 17. The Turkish names of the duodecennial animal-cycle, appearing in Persian literature (1).

	Turkish	Persian	English equivalent
1	Sīchqān	Mūsh	Mouse (rat)
2	Ud	Gāv (Baqar)	Ox (bull)
3	Bārs (Pārs)	Palang (Yuz)	Tiger (cheetah; leopard)
4	Tūshqān	Khargūsh	Rabbit (hare)
5	Lūy	Nahang (Azhdahā; Azhdarhā)	Dragon (crocodile)
6	Īlān	Mār	Snake (serpent)
7	Yūnt	Asb	Horse
8	Qūy	Gūsfand	Lamb (ram; sheep)
9	Pīchī (Pīchīn)	Maymūn (Hamdūna; Būzīna)	Monkey
10	Takhāqū	Murgh	Hen (cock)
11	Īt	Sag	Dog
12	Tungūz	Khūg	Pig (hog; boar)

1. For Kāshghari and Mongolian animals in their Turkish forms, used by tenth-century (A.D.) authors, see Minorsky (1942), p.81.

Table 18. Solar-Hijrī and Jalālī leap-years from S.H.1304 to S.H.1354.

Solar-Hijrī leap-year	Jalālī equivalent	Wüstenfeld-Mahler	Khāzinī	Naṣīr al-Dīn
1304	847	847	850	848
1309	852	851	854	852
1313	856	855	858	856
1317	860	859	862	860
1321	864	863	866	864
1324	868	868	870	869
1329	872	872	875	873
1333	876	876	879	877
1337	880	880	883	881
1342	885	884	887	885
1346	889	888	891	889
1350	893	892	895	893
1354	897	897	899	897

Table 19. Aggregate month-day totals of Iranian calendars (see pp.174 ff.).

Early Yazdgirdī		Yazdgirdī, post A.D.1006		Original Jalālī	
Farvardīn	0	Farvardīn	0	Farvardīn	0
Urdībihisht	30	Urdībihisht	30	Urdībihisht	30
Khurdād	60	Khurdād	60	Khurdād	60
Tīr	90	Tīr	90	Tīr	90
Murdād	120	Murdād	120	Murdād	120
Shahrīvar	150	Shahrīvar	150	Shahrīvar	150
Mihr	180	Mihr	180	Mihr	180
Ābān	210	Ābān	210	Ābān	210
Epagomenae	240	Ādhar	240	Ādhar	240
Ādhar	245	Daī	270	Daī	270
Daī	275	Bahman	300	Bahman	300
Bahman	305	Isfandārmadh	330	Isfandārmadh	330
Isfandārmadh	335	Epagomenae	360	Epagomenae	360

Table 20. Aggregate month-day totals of Iranian, Christian and Syrian calendars (see pp.174 ff.).

Solar-Jalālī		Solar-Hijrī/ Shāhanshāhī		Christian	Common	Leap	Syrian	Common	Leap
Hamal	0	Farvardīn	0	Jan.	0	0	Tishrin I	0	0
Thawr	31	Urdībihisht	31	Feb.	31	31	Tishrin II	31	31
Jawjā	62	Khurdād	62	March	59	60	Kanun I	61	61
Saraṭān	94	Tīr	93	April	90	91	Kanun II	92	92
Asad	125	Murdād	124	May	120	121	Shubat	123	123
Sunbula	156	Shahrīvar	155	June	151	152	Adar	151	152
Mīzān	187	Mihr	186	July	181	182	Nisan	182	183
ʿAqrab	217	Ābān	216	Aug.	212	213	Ayyar	212	213
Qaws	247	Ādhar	246	Sept.	243	244	Haziran	243	244
Juday	276	Daī	276	Oct.	273	274	Tammuz	273	274
Dalw	305	Bahman	306	Nov.	304	305	Ab	304	305
Hūt	335	Isfand	336	Dec.	334	335	Elul	335	336

Table 21. Perpetual lunar-Hijri calendar (1).

1. Cycle							4. Month
44	48	45	42	46	43	47	
37	41	38	35	39	36	40	
30	34	31	28	32	29	33	
23	27	24	21	25	22	26	
16	20	17	14	18	15	19	
9	13	10	7	11	8	12	
2	6	3	0	4	1	5	
2. Year							3. Key
0	5	8	13	21	29	1	2	3	4	5	6	7	Jum. II; Dhu-Q.
3	11	16	19	24	27	2	3	4	5	6	7	1	Ṣafar; Rajab
6		14		22	30	3	4	5	6	7	1	2	Rab. I; Dhu-H.
1	9	17		25		4	5	6	7	1	2	3	Sha‘bān
4		12		20	28	5	6	7	1	2	3	4	Rab. II; Ramaḍān
7		15		23		6	7	1	2	3	4	5	Jum. I
2		10	18	26		7	1	2	3	4	5	6	Muḥ.; Shaw.

5. Month-day													6. Week-day
	7	14	21	28		Th	Wed	Tu	Mon	Sun	Sat	Fri	
	6	13	20	27		Wed	Tu	Mon	Sun	Sat	Fri	Th	
	5	12	19	26		Tu	Mon	Sun	Sat	Fri	Th	Wed	
	4	11	18	25		Mon	Sun	Sat	Fri	Th	Wed	Tu	
	3	10	17	24		Sun	Sat	Fri	Th	Wed	Tu	Mon	
	2	9	16	23	30	Sat	Fri	Th	Wed	Tu	Mon	Sun	
	1	8	15	22	29	Fri	Th	Wed	Tu	Mon	Sun	Sat	

(1). See Abdollahy (1352 H.S.), pp.738-739.

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A.J.P.	American Journal of Philology
A.J.S.L.L.	American Journal of Semitic Languages and Literatures
Berytus	Berytus: Archaeological Studies; American University of Beirut
B.S.O.A.S.	Bulletin of the School of Oriental and African Studies (formerly B.S.O.S.)
C.A.R.	Central Asian Review
C.M.V.	The K. R. Cama Memorial Volume: Essays on Iranian Subjects written by Various Scholars in Honour of Kharshedji Rustamji Cama, ed. J.J. Modi, Bombay, 1900.
J.A.O.S.	Journal of the American Oriental Society
J.C.O.I.	Journal of the K. R. Cama Oriental Institute
J.C.S.	Journal of Cuneiform Studies
J.H.S.	Journal of Hellenic Studies
J.J.M.J.M.V.	Sir Jamsetjee Jejeebhoy Madressa Jubilee Memorial Volume: Papers on Iranian Subjects Written by Various Scholars in Honour of the Jubilee of Sir Jamsetjee Jejeebhoy Zarthoshti Madressa, ed. J.J. Modi, Bombay, 1914.
J.N.E.S.	Journal of Near Eastern Studies
J.N.S.I.	Journal of the Numismatic Society of India
J.R.A.S.	Journal of the Royal Asiatic Society
J.S.S.	Journal of Semitic Studies
K.M.V.	M. P. Kharegat Memorial Volume I: A Symposium on Indo-Iranian and Allied Subjects, Bombay, 1953.
M.D.A.	Majalla-yi Danishkada-yi Adabiyyāt-i Tehran

M.M.V.	Dr. Modi Memorial Volume: Papers on Indo-Iranian and Other Subjects Written by Several Scholars in Honour of Shams-ul-ulama Dr. Jivanji Jamshedji Modi, ed. by the Dr. Modi Memorial Volume Editorial Board, Bombay, 1930.
M.N.R.A.S.	Monthly Notices of the Royal Astronomical Society
N.C.	The Numismatic Chronicle
P.M.V.	Oriental Studies in Honour of Cursetji Erachji Pavry, ed. Jal Dastur Cursetji Pavry, foreword by A.V. Williams Jackson, London, 1933.
S.M.V.	Indo-Iranian Studies: being Commemorative Papers Contributed by European, American and Indian Scholars in Honour of Shams-ul-ullema Dastur Darab Peshotan Sanjana, London, 1925. (S.M.V. = Sanjana Memorial Volume).

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Zīj-i Mufrad (O.1(10)): see under Abū Ja'far Muḥammad b. Ḥāsib al-Ṭabarī.

Zīj-i Mumtaḥan (Gg.3.27): see under Muḥammad b. Abū Bakr al-Fārsī.

Zīj-i Shāhjahānī (Or. 372): see under Farīd Ibrāhīm Dihlavī.

Zīj-i Ulugh Beg (1847): see under Ulugh Beg.