The Date of the Hsia Calendar *Hsia Hsiao Chêng*.

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IN a well-known collection of ritual notes, the *Ta Tai Li* 大戴禮 (*The Rites of the Elder Tai*), considered to be earlier than the Han period (206 B.C.), there is a calendar section (No. 47), termed *Hsia Hsiao Chêng* 夏小正 (*The Lesser Canon of the Hsia*), which is traditionally regarded as a true relic of the Hsia dynasty (about 2000 B.C.). It was translated by Professor R. K. Douglas (*Orientalia Antiqua*, 1882) and was regarded by him and some other students as of great antiquity. On the other hand, it is very difficult to understand, in the light of modern discoveries as to the Shang culture (*circa* 1200 B.C.), how such a document could have been produced in 2000 B.C., and the more conservative students are unwilling to admit that it can be much older than, say, 500 B.C.

The document is practically a farmer's calendar, but it includes comments on weather, the stars, animal and vegetable life, all arranged under the twelve moons of the year. The style is very terse, but includes explanatory remarks which seem to indicate that it has absorbed a brief commentary into the text.

It is the object of the following notes to discuss the astronomical content of this calendar and hence the date of its composition. The latter can be deduced to a certain extent by the shift of the star positions at a given time of day on a given day of the year, due to the precession of the equinoxes resulting from the earth's third rotation (about the axis of the ecliptic once in 26,000 years).

The botanical and zoological matters it contains (e.g. in the eleventh moon the words "stags' antlers fall") cannot, of course, serve to date it, but do fix the position of its months in the tropical or climatic year. There is, however, no doubt

about the latter from an astronomical point of view. Although the calendar refers to "moons" 月 (the customary Chinese civil reckoning being by lunations) it is definitely a tropical one with the winter solstice (23rd December, Gregorian style) in the eleventh moon. Hence a reference to a particular moon must only be taken as relating to the average position of that lunation in the tropical year, maintained by the intercalation every two or three years of an extra moon. Since a "moon" is slightly over 29½ days and a "month" is slightly over 30½ days, in any one particular year a particular moon may shift backwards or forwards from the average position by an amount less than fifteen days. This would seem to introduce an uncertainty of over 1,000 years in the precessional dating, but it seems clear that the calendar refers definitely to the average position, and hence for the purpose of comparison it is not necessary to consider the lunation as distinguished from one-twelfth of the tropical year.

The essential arrangement of the Hsia calendar, which was officially adopted for civil reckonings in 104 B.C. in the Han dynasty and remained (with short interruptions) in use as a standard in China until A.D. 1927, was that the first, fourth, seventh, and tenth moons should inaugurate the four seasons and that the second, fifth, eighth, and eleventh moons should contain (more or less centrally) the equinoxes and solstices. It should be remarked that what the Greek and modern astronomers consider the beginnings of the four seasons the Chinese consider the middles, e.g. the Chinese consider that spring commences halfway between the winter solstice (23rd December) and the vernal equinox (21st March), i.e. on 4th or 5th February,[1] and not at the vernal equinox.

Given this system, the dates in the year and the times of dawn and dusk, in latitude 35 degrees north (Hsi-an, Lo-yang, and K'ai-fêng all lie near this latitude), during the Hsia year are as follows :—

[1] Two days later if the sun's motion is assumed to be uniform, as was thought to be the case in Han times.

Moon.	*"Normal" beginning.*	*Dawn.* a.m. hr.	min.	*Dusk.* p.m. hr.	min.
First	5th February	5	18	6	42
Second	6th March	4	48	7	12
(Vernal Equinox)	21st March	4	45	7	15
Third	6th April	4	02	7	58
Fourth	6th May	3	32	8	28
Fifth	7th June	3	02	8	58
(Summer Solstice)	22nd June	2	58	9	02
Sixth	8th July	3	02	8	58
Seventh.	8th August	3	32	8	28
Eighth	8th September	4	02	7	58
(Autumnal Equinox)	23rd September	4	45	7	15
Ninth	9th October	4	48	7	12
Tenth	8th November	5	18	6	42
Eleventh	8th December	5	31	6	29
(Winter Solstice)	23rd December	5	34	6	26
Twelfth	6th January	5	31	6	29

These times are "apparent", not "mean" time, which introduces another uncertainty averaging about plus or minus six minutes (say 200 years of precessional time), and are given by Chinese observers as those at which the stars cease to be or become visible.

The Text

The text of the *Hsia Hsiao Chêng*, as far as astronomical references only are concerned, is as follows:—

"*First Moon.*

"Chü 鞠 then appears. What is Chü? Chü is a star name. 'Chü then appears' means that in the year it has again appeared.

"In the beginning [of the month] at dusk Shên 參 (Orion) is in the middle (South), then recording the season.

"The Tail of the Dipper hangs down below. The saying 'Tail of the Dipper' therefore shows Ts'an in the middle."

The commentators suggest that the lunar asterism Liu 柳 (δ to ω Hydrae) is equivalent to Chü; Liu rises when Orion is in the South.

Taking dusk at 6.42 p.m., it will be found that Orion souths now (say A.D. 1900 for simplicity) about 6th March. Owing to precession the date of southing of a star at a fixed

time of day advances one month in about 2,250 years, so that this corresponds for 5th February to about 350 B.C., with a possible error of plus or minus about 150 years.

(*Note.*—The precessional motion in celestial longitude along the ecliptic is 30 degrees in 2,160 years. If the star position happens to be close to an equinox this corresponds to 27½ degrees of right ascension, or 30 degrees of right ascension in 2,350 years. For positions near the solstices the angular movements in longitude and right ascension are in reverse ratio, the true average being 30 degrees of right ascension in 2,160 years. It so happens that most of the data are near the equinoxes and one month shift has been taken as 2,250 years for simplicity. No precision is possible.)

When the Tail of the Dipper (Ursa Major) hangs vertically in the north-east, Orion is in the south, as stated.

"*Second Moon.*"

(Nil.)

"*Third Moon.*

"Stars without season and do not appear."

This suggests that there are no particular stars to indicate this month.

"*Fourth Moon.*

"Mao 昴 (Pleiades) then appears.

"In the beginning [of the month] at dusk Nan Mên 南門 (Centaurus) is exact. Nan Mên is a star that in the year again appears."

The Pleiades in Latitude 35° N. rise at 3.32 a.m. now early in June corresponding to early May some 2,250 years ago.

Nan Mên (α and β Centauri) lie far south and are only visible for part of the year in latitude 35° North. The group is almost exactly south of Arcturus (α Boötis), which souths now at 8.28 p.m. early in June, or about one month later than the fourth moon day of 6th May, corresponding again to some 2,250 years ago.

"*Fifth Moon.*

"In the beginning [of the month] at dusk Ta Huo 大火 is

in the middle (South). Ta Huo is Hsin 心 (one of the twenty-eight Lunar Mansions including σ, α, and τ Scorpii). Hsin is in the middle."

At 8.58 p.m. Antares (α Scorpii) souths now on 12th July, or one month and five days later than 7th June, corresponding to about 2,600 years ago, or say 700 B.C. This is the earliest indication found, but if Ta Huo corresponds to Hsin *and* Fang 房 (β to ν Scorpii) the southing of the whole group is 7th July, reducing the interval once again to the same 2,250 years. Ta Huo is the second of the Jovian duodecimal divisions of the Chinese equatorial planet belt, and includes as such the three lunar asterisms Ti 氐, Fang, and Hsin with Fang in its centre, not Hsin. (Ti is from α to ι Librae.)

Huo (" Fire ") is one of the cardinal star points in the *Yao Tien* 堯典 (*Canon of Yao*) in the Chinese *Shu Ching* (*Book of History*), referred to in the appendix. Hsin (" Heart ") alludes to the heart of the Green Dragon, a name given to the eastern quadrant of the equatorial band, the time being midnight at the winter solstice. " Ta Huo is Hsin " looks like a comment added to the text.

" *Sixth Moon.*

" At the beginning [of the month] at dusk the Tail of the Dipper is exactly upright.

" In the fifth moon Ta Huo was in the middle (South). In the sixth moon the Tail of the Dipper is exactly upright. Use this to compare the appearance. If the tail does not agree with Hsin it then conforms to I 依. I is Wei 尾 (the Tail of the Dragon, ε to λ Scorpii)."

This cannot be controlled at all exactly. The Tail of the Great Bear at 8.58 p.m. is perpendicular (upwards) to the horizon at about the beginning of August now (in lat. 35 N.) and therefore early in July 2,250 years ago. Wei souths at 8.58 p.m. now about 25th July, which is too early. The text seems to indicate that Wei gives an intermediate indication. The remark " I is Wei " again looks like an added comment.

Rather remarkably in the *Yüeh Ling*, or calendar section of the *Li Chi* (*Ritual Records*), the dusk culmination of Huo is put in the sixth moon which is practically its position at the present time. There must be an error in the *Yüeh Ling*, which agrees with the document under discussion in putting the culmination of Orion at dusk in the first moon. The *Yüeh Ling* is generally considered to be a compilation of the third century B.C.

"*Seventh Moon.*

"In the beginning [of the month] at dusk Chih Nü 織女 ('The Weaving Girl,' ε and α Lyrae) is exactly east directed.

"The Tail of the Dipper hangs below and then it is dawn."

At 8.28 p.m. Vega (α Lyrae) is almost overhead in early September with the line of the two stars towards the east, and would have been so one month earlier 2,250 years ago, but this is a very rough indication. Similarly, the Tail of the Great Bear hangs perpendicular to the horizon before dawn at 3.32 a.m. early in September, and would have been so at dawn in August 2,250 years ago.

"*Eighth Moon.*

"The Ch'ên 辰 (conjunction point, probably Hsin and Fang, equal to Scorpio) then declines. The Ch'ên is a star. Declines means goes in and does not appear."

This seems to allude to the fact that at 7.58 p.m. early (now) in October Scorpio sets, corresponding to dusk in early September 2,250 years ago.

The character *ch'ên* 辰 is used in various ways, but one of its standard meanings is "conjunction point for the sun and moon" and the two important *ch'ên* were Shên (Orion) and Huo (Scorpio). Here again observe the comment.

"*Ninth Moon.*

"The Huo within, the Huo within. The Ta Huo, Ta Huo is Hsin."

This simply seems to mean that Scorpio has set, which is a fact.

"*Tenth Moon.*

"Nan Mên appears. Nan Mên is a star. Reaching this (time) it again appears."

Nan Mên (Centaurus) is referred to in the fourth moon. Being so low its arc in the sky in latitude 35° N. is short and it will only be seen in the southern quarter. At 5.18 a.m. early in December it now rises and so (at dawn) in November 2,250 years ago.

"*Eleventh Moon.*

"The sun's Winter limit."

This is the only reference to the sun, but it quite definitely fixes the relation of the numbers of the moons to the seasons.

"*Twelfth Moon.*"

(Nil.)

All the data are consistent with the astronomical conditions in about 350 B.C., which is the epoch at which Shih Shên 石申 and Kan Tê 甘德 first collected moderately exact data on astronomical matters.

It is also the time at which, in the West, Kidinnu and Naburiannu flourished and provided the Greeks with the data which were so powerfully developed by Eudoxos and Hipparchos. The Chinese were much behind the Seleucid Babylonians in their grasp of astronomy, and did not master the oblique motion of the planets until the second century A.D.

No attempt has been made to deduce any exact date by refinement of the calculations since the data and times do not warrant it. Similarly only rough allowance has been made for the differences between celestial longitude and right ascensions which are of smaller order than the degree of approximation in the day of the year and the time of day.

On account of this roughness of the data, the date *might* be pushed back to say 700 B.C., or conversely could be drawn down almost to the early Han period (206 B.C.), although the latter is not probable because of the much superior data given in the *Shih Chi* (*Historical Records*) of Ssŭ-ma Ch'ien (*circa*

100 B.C.) and in the *Ch'ien Han Shu Lü Li Chih* 前漢書律曆志 (*Treatise on Metrology and the Calendar* in the *Former Han History*, composed early in the first century of the Christian era).

In any case this calendar cannot be of the Hsia period (traditional date, now known to be erroneous, 2205–1766 B.C. ; possible date 2000–1500 B.C.), since this is far beyond the limits of error in the precessional calculations given above.

The astronomical content of the calendar differs very much in style from the allegedly very early *Yao Tien* in the *Book of History*, and also from the very systematic *Yüeh Ling*. Emphasis is placed on the three great star groups which we call Orion, Scorpio, and the Great Bear, rather than on the twenty-eight asterisms only a few of which occur, rather casually and in some cases under names which are different from those current in the Han books. If this document is, as it appears, later than 700 B.C., the formal arrangement and names of the twenty-eight asterisms would seem to be of still later date and the rather precise system of the four quarter stars in the *Yao Tien*, which is the basis of the reputed great antiquity of that calendar, becomes still more surprising.

Appendix

The Riddle of the Yao Tien Calendar

It requires extreme temerity to refer to the much discussed antiquity of the *Yao Tien* calendar, upon which the Hsia calendar is traditionally based. All the modern sinological evidence seems to be against it really representing a record dating back to 2400 B.C., and yet the astronomical evidence seems to point that way. De Saussure devoted over twenty-five years to its study and his main arguments are very hard to overthrow.

Stripped of all detail, the Yao calendar asserts that the equinoxes and solstices are marked by four stars :—

(21st March)	Spring Equinox	by Niao 鳥 "The Bird"
(22nd June)	Summer Solstice	Huo 火 "Fire"

(23rd September) Autumn Equinox	Hsü 虛 " Void "
(23rd December) Winter Solstice	Mao 昴 " Pleiades " or " Sun Gate "

Whatever the original document may have meant, it is certain that in Han times these four were identified with the four lunar asterisms :—

Ch'i Hsing 七星 (" Seven Stars ")	α to ν Hydrae
Hsin 心 (" Heart ")	σ to τ Scorpii
Hsü 虛 (" Void ")	β Aquarii and α Equulei
Mao 昴 (" Pleiades ")	η Tauri and surrounding stars

and it is a fact that these four star groups coincided (within a very few degrees) with the solstices and equinoxes about 4,320 years ago and culminated at 6 p.m. mean time on the days stated. Excepting the winter one, however, these culminations (southings) would not be visible, and in the case of the winter solstice some form of timekeeper would have been necessary to fix the time. De Saussure has argued that these positions were deduced from the location of the full moon amongst the stars. There is no doubt that such a method might have been used, and there is also no doubt that the whole very elaborate symmetry of the Chinese subdivision of the celestial equatorial band and its relation to the day and year, as it appears in the Han records, does presuppose these four in the alleged quadrantal positions. This system predates any *exact* estimate of the precession of the equinoxes by which alone the positions in 2400 B.C. might have been computed. The date of Yao was given by Mencius (*circa* 300 B.C.) as about 2100 B.C., and the origin of the calendar was attributed popularly in Han times to Huang Ti, who is put three or four hundred years before Yao, i.e. to 2400 B.C.

Two of the four star names are vague. Niao " the Bird " (the Vermilion Bird of the Southern Quadrant) includes in its widest sense seven of the asterisms (Tung Ching or μ Geminorum to Chen 軫 or γ Corvi) and so

allows a wide uncertainty (90 degrees or 6,480 years of precessional time).

Huo ("Fire") is one of the duodecimal divisions of the equator, representing the annual displacement of the planet Jupiter, called Ta Huo ("Great Fire"), and includes three of the asterisms (Ti to Hsin, covering the constellations Libra and Scorpio), allowing an uncertainty of 30 degrees or say 2,250 years, being near to an equinox.

Hsü and Mao, on the other hand, are single asterisms of small range in longitude (about 8 degrees), which only allows an uncertainty of about 600 years.

Schlegel and de Saussure both vigorously combat the idea that dusk culminations could have decided the matter.

Hsü culminates now (1900 for simplicity) at 7.15 p.m. on the 23rd October, just one month after the autumn equinox, which corresponds to 2,250 years ago or say 350 B.C., which would conform to a late date for the Yao Tien, but Mao will not fit this at all.

Mao culminates at winter solstice dusk (6.26 p.m.) now on the 9th February, which is one and a half months after the winter solstice, corresponding to about 3,300 years ago, or 1400 B.C. This is the latest date if the dusk culminations are used, and Hsü fits this very badly indeed. The difference between these two is the first main discrepancy in the case against the quadrantal positions and the consequently implied 2400 B.C. date.

As to Huo, at 9.02 p.m. (summer solstice dusk), using the full extent of the three asterisms, dusk culmination now can occur at any date from 17th June to 15th July. Even the latest of these days is not late enough to make the date of composition later than A.D. 100, which is quite impossible. This is the second discrepancy.

Thus the case for the great antiquity of the astronomical content of the *Yao Tien* is vastly stronger than it is for that of the *Hsia Hsiao Chêng*. H. Maspèro has developed a very interesting theory that the *Yao Tien* text includes an

euhemerized myth of a Sun-goddess Hsi-Ho 羲和, which is quite plausible, but he has not ventured to disturb de Saussure's main argument, and there is no necessary inconsistency in a myth containing a genuine astronomical tradition.

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