

Solar and Lunar Eclipse Records in Vietnamese Historical Sources — From Ancient Times through 18th Century —

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Abstract

We present the results of our survey of solar and lunar eclipse records from ancient times through 18th century in two important Vietnamese historical sources; *Dại Việt Sử Ký Toàn Thư* (including *Dại Việt Sử Ký Tục Biên*) and *Việt Sử Lược*. We found 92 solar eclipse and 55 lunar eclipse records in both the sources. We discuss the reliability of these eclipse records by comparing with astronomical simulation results, and consider whether they were based on observation or prediction. We also discuss a possible relation between these eclipse records and Vietnamese old calendar system as well as the beginning of a day considered in Vietnam of those days based on these lunar eclipse records. In addition, we found 29 solar eclipse records in another historical source, which are also discussed in comparison with the records in the above sources.

1. Introduction

It is well known that many astronomical records are found in Chinese, Korean and Japanese historical sources. Although less known, a considerable number of astronomical records have been also found in some Vietnamese historical sources. We are concerned here with solar and lunar eclipse records in Vietnam from ancient times through 18th century on the basis of our recent studies (Tanokura and Okazaki, 2011; Okazaki and Tanokura 2012; Okazaki, 2013; Okazaki 2014) and also our recent further investigations,

We surveyed two important Vietnamese historical sources.

One of them is *Việt Sử Lược* (VSL, 越史略 *Abridged Chronicles of Vietnam*), which is believed to be published in 13th century. Although VSL has been perished in Vietnam, it has been conserved in a few Chinese library series, such as *Shoushange congshu* (守山閣叢書).

Another important source is *Dại Việt Sử Ký Toàn Thư* (大越史記全書 *Complete Annals of Great Vietnam*), which is the official historical text of the Later Lê dynasty compiled by royal historians from 15th through 17th centuries. It covers a period from ancient times to AD1675. In addition, there is another text entitled *Dại Việt Sử Ký Tục Biên* (大越史記續編, *Sequel of Annals of Great Vietnam*), which covers a period from AD1676 to AD1789 (the end of the dynasty). This text, compiled by later royal historians, is considered literally as the sequel of the above text. Hereafter, a combined text of the above two will be referred to as “TT” and the former text alone as TT *without the sequel*.

In addition to VSL and TT, there is a third important historical source, which will be mentioned in subsection 4.5.

Ho Peng-Yoke (1964) listed the natural phenomena (including many astronomical ones) recorded found in TT. Okazaki and Yokoo (1983) also surveyed the astronomical records in VSL.

2. Vitnamese old calendars

Before dealing with solar and lunar eclipse records, we will mention Vietnamese luni-solar calendars used in those days. It has been considered that they were very similar to Chinese ones of those days. In fact, Chinese calendars have been used in some previous works on Vietnamese historical records (e.g., Ho Peng-Yoke, 1964).

It is only a few decades ago that Vietnamese old calendars were reconstructed by Hoàng Xuân Hãn (1982) and Lê Thành Lân (2007). For example, Lê Thành Lân (2007) published a calendar conversion table entitled *Conversion table between solar (Julian/Gregorian) calendars and Vietnamese / Chinese lunar (lunii-solar) calendars for 2030 years (AD0001–2030)*. In this table, which is used in our study, Vietnamese calendar before AD1544 has not been reconstructed and are assumed to be the same as Chinese one because of no available calendar materials of those days. On the other hand, Hoàng Xuân Hãn (1982) investigated a relation between Vietnamese and Chinese old calendars as well. His conclusion is summarized in table 1.

Table 1: Vietnamese old calendar systems (Hoàng Xuân Hãn, 1982)

(1) Before early 10th century
Unknown (little available data)
(2) ~AD 939–~1078
Probably, the same that used in China.
(3) ~AD1080–~1300
Not the same that used in China, though the system is unknown.
(4) ~AD1306– 1644
The same that used in China (Shoushi li 授時曆 / Datong li 大統曆), and calculations were made by Vietnamese.
(5) AD1645– 1812
Not the same that used in China because Chinese calendar system was changed in late AD 1644 while Vietnamese system remained Shoushi li 授時曆 / Datong li 大統曆.

3. Survey results

According to Chen Chingho (1984–86), who published a collated version of TT, there are a few records for which some versions of TT say “solar eclipse (日食)” while others “lunar eclipse (月食)”. We also find a few eclipse records saying, for example, “there was a *solar eclipse* (日食) on the full moon day” or “there was a *solar eclipse* (日食) someday around 15th day of the lunar month,” both of which should be regarded as a lunar eclipse because of the occurrence date. Such confusion between the two characters “日 (Sun)” and “月 (Moon),” similar to one another, are occasionally found in other historical sources written in classical Chinese as well. Then, we have checked a described occurrence date for each eclipse record to judge whether it is really solar eclipse or lunar one.

3.1. Solar eclipse records

We found 6 and 89 solar eclipse records in VSL and TT, respectively. Among them, three records are common, which means that 92 solar eclipse records are found in total. The number of the records in VSL is

in agreement with that of Okazaki and Yokoo's (1983) survey results. On the other hand, 71 of 89 records in TT are those found in TT *without the sequel*, from which Ho Peng-Yoke (1964) listed 69 solar eclipse records.

Figure 1 shows a part of the catalog of these solar eclipse records in and after 10th century, which is contained in Tanokura and Okazaki (2011). The catalog, whose explanation is written in Japanese, gives (1) the sequential number of the record, (2) the description of the record, (3) recorded date of eclipse in Julian/Gregorian calendar in yyyy.mm.dd format, (4) the calculated date in Hanoi in yyyy.mm.dd format based on simulation, (5) a symbol which represents the magnitude of eclipse, (6) the description of the record in a Chinese source, if any, (7) the catalog number of Oppolzer's (1887) canon of eclipses, and (8) remarks.

For details, see Tanokura and Okazaki (2011).

表 A1 『大越史記全書』と『越史略』の日食記事

番号	記載内容	西暦換算	計算結果	見え方	中国史書の記事	Oplzr	備考 (本文参照)
1	興統五年, 春二月己未朔, 日食	993.02.24	993.02.24	△	二月己未朔, 日有食之 (宋史・天文五)	5225	
2	應天五年, 夏五月戊午朔, 日食	998.05.28	998.05.28	×	五月戊午朔, 日有食之 (宋史・天文五)	5238	
3	應天五年, 冬十月丙戌朔, 日食	998.10.23	998.10.23	×	十月丙戌朔, 日有食之 (宋史・天文五)	5258	
4	天成元年, 春三月丙申朔, 日食	1028.03.29	1028.03.29	×	三月丙申朔, 日有食之 (宋史・天文五)	5307	
**5	乾符有道二年, 春正月丁亥朔, 日食	1040.02.15	1040.02.15	◎	正月丙辰朔, 日有食之 (宋史・天文五)	5334	中国と日の干支の違い
6	太平四年, 秋八月庚寅朔, 日食	1075.09.13	1075.09.13	×	八月庚寅朔, 日有食之, 雲陰不見 (宋史・天文五)	5464	
*7	會豐二年, 冬十月朔, 日有食之	1093.10.23	1093.09.23	—	—	(5420)	非食 (+1ヶ月)?
*8	龍符五年, 十一月朔, 日食過半	1105.12.09	1106.02.05	—	—	—	非食 (-3ヶ月)
9	貞符八年, 冬十一月壬午朔, 日食	1183.11.17	1183.11.17	△	十一月壬戌朔, 日食于心 (宋史・天文五)	5691	中国と日の干支の違い
*10	天資嘉瑞三年, 春二月丁卯朔, 日有食之	1188.02.29	1188.02.29	×	—	5702	
11	天資嘉瑞三年, 秋七月甲子朔, 日食	1188.07.26	1188.08.24	—	[八月甲子朔, 日食于翼 (宋史・天文五)]	(5703)	非食 (-1ヶ月)?
**12	天資嘉瑞四年, 春二月辛酉朔, 日食	1189.02.17	1189.02.17	◎	二月辛酉朔, 日有食之, 陰雲不見 (宋史・天文五)	5704	
*13	治平龍應二年, 二月壬子朔, 日有食之	1206.03.11	1206.03.11	△	二月壬子朔, 日食 (金史・天文)	5747	
14	建中五年, 春三月, 日有食之	1229.03.27	1229.06.22	—	—	—	非食 (-3ヶ月)
15	天應政平十一年, 九月庚辰朔, 日食	1242.09.26	1242.09.26	◎	九月庚辰朔, 日有食之 (宋史・天文五)	5840	
16	天應政平十八年, 夏四月壬寅朔, 日食	1249.05.14	1249.05.14	◎	四月壬寅朔, 日有食之 (宋史・天文五)	5857	
17	紹隆三年, 春三月戊辰朔, 日食	1260.04.12	1260.04.12	◎	三月戊辰朔, 日有食之 (宋史・天文五)	5884	
18	寶符三年, 夏六月庚子朔, 日有食之既	1275.06.25	1275.06.25	◎	六月庚子朔, 日食既, 星見 (宋史・天文五)	5922	
19	重興三年, 冬十月朔, 日食	1287.11.07	1287.11.07	△	十月戊午朔, 日有食之 (元史・天文一)	5951	

Figure 1: A part of the catalog of solar eclipse records in and after 10th century in VSL and TT (Tanokura and Okazaki, 2011)

3.2. Lunar eclipse records

We find no lunar eclipse records in VSL in agreement with Okazaki and Yokoo's (1983) results. On the other hand, we found 55 lunar eclipse records in total in TT. It may be noted that 38 of them are those found in TT *without the sequel*, from which Ho Peng-Yoke (1964) listed 34 lunar eclipse records.

Figure 2 shows a part of the catalog of these lunar eclipse records, which is included in Okazaki (2014). The catalog gives (1) the sequential number of the record, (2) the recorded date of eclipse in Julian/Gregorian calendar in yyyy.mm.dd format, (3) the recorded dates in Chinese, Korean and Japanese historical sources if they exist, (4) the results of simulated calculation in Hanoi: the occurrence date, local true solar time and the Moon's altitude (at the start, the greatest [together with its magnitude and, in the case of totality, the time duration of total eclipse in parentheses] and the end time), and (5) catalog numbers of Oppolzer's (1887) and Watanabe's (1979) canon of eclipses and Ho Peng-Yoke's (1964) lunar eclipse list number.

For details, see Okazaki (2014).

Table 1 Lunar Eclipse Records in *Dại Việt Sử Ký Toàn Thư*

No.*	Recorded Date	Recorded Date in			Simulation Results				Other catalog		
	Julian/Gregorian	China	Korea	Japan	Date	Local true solar time and Moon altitude in Hanoi			number [‡]		
	yyyy.mm.dd [†]	mm.dd	mm.dd	mm.dd	yyyy-mm.dd	Eclipse start	Greatest (Mag. Totality)	Eclipse end	O	W	H
1	(1169.04.13)	03.14	03.14	03.15	1169.03.14	26:10 51°	27:30 34° (0.60, —)	28:49 16°	3676	0354	01
2	1306.10.22	—	10.22	10.22	1306.10.22	19:03 20°	20:42 42° (1.05, 0h35m)	22:22 65°	3895	0525	02
3	(1388.11.13)	11.14	11.14	—	1388.11.14	18:14 11°	19:55 33° (1.33, 1h17m)	21:36 55°	4017	0630	03
4	1437.04.20	04.20	04.20	04.20	1437.04.20	22:28 49°	23:09 53° (0.15, —)	23:50 55°	4091	0693	04
5	(1439.08.24)	08.24	08.24	08.24	1439.08.24	19:27 18°	21:09 39° (1.35, 1h20m)	22:50 56°	4094	0698	05
6	(1443.06.12)	06.12	06.12	06.12	1443.06.12	19:14 08°	21:12 29° (1.82, 1h47m)	23:09 43°	4100	0705	06
7	(1444.11.24)	—	—	—	1444.11.25	PENUMBRAL ECLIPSE			—	0708	07
8	1448.09.13	—	—	—	1448.09.12	28:50 16°	29:22 08° (0.09, —)	29:55 01°	4107	—	—
9	1465.04.11	04.11	—	04.11	1465.04.11	19:38 19°	21:23 39° (1.26, 1h13m)	23:07 54°	4131	0732	08
10	1476.03.11	03.10	03.10	03.10	1476.03.10	23:25 68°	25:14 63° (1.12, 0h55m)	27:03 42°	4148	0745	09
11	1476.09.03	09.04	09.04	—	1476.09.03	27:54 26°	29:39 04° (1.29, 0h37m)	29:54 set	4149	0746	—
12	1478.01.18	01.18	—	01.18	1478.01.18	23:57 86°	24:16 85° (0.03, —)	24:35 81°	4150	0749	10
13	1479.01.08	01.08	—	01.08	1479.01.08	PENUMBRAL ECLIPSE			4152	0750	11
14	1482.10.26	10.26	—	10.26	1482.10.26	22:20 66°	23:58 84° (0.89, —)	25:37 67°	4157	0755	12
15	1525.07.05	—	—	07.05	1525.07.04	27:45 20°	28:36 10° (0.21, —)	29:26 set	4220	0806	13
16	1525.12.30	—	—	12.30	1525.12.29	26:31 54°	28:17 31° (1.10, 0h50m)	30:03 08°	4221	0807	14

Figure 2: A part of the catalog of lunar eclipse records in TT (Okazaki, 2014)

4. Discussion

4.1. Reliability of the eclipse records

4.1.1. Eclipse records before 10th century

Figure 3 displays the number of records of solar and lunar eclipse records in TT and VSL for every 100 years. We see from the figure that, although solar and lunar eclipse records roughly show a similar tendency in and after 10th century, not so before 10th century: while there exist more than 20 solar eclipse records, most of which fall into a period from $\sim 200\text{BC}$ to $\sim 100\text{BC}$, there exist no lunar eclipse records.

It is noted that comet appearance records in TT before 10th century also display such a tendency as shown by solar eclipse records (see Ho Peng-Yoke's [1964] comet record list). All the records, including doubtful ones, of solar eclipse and comet appearance in BC era in TT are almost the same as those in Chinese official history *Hanshu* (漢書), except for a sentence form difference between “日食” in TT and “日有食之” in *Hanshu*, both of which mean that “there was a solar eclipse”.

Therefore, we suggest that the records of BC era in TT have been copied from *Hanshu*.

4.1.2. Eclipse records in and after 10th century

We consider that the above mentioned tendency of the number of the records would be strongly connected with the historical fact Vietnam became independent from China in 10th century. Thus, we confine our attention to 69 solar eclipse records and 55 lunar eclipse ones in and after 10th century.

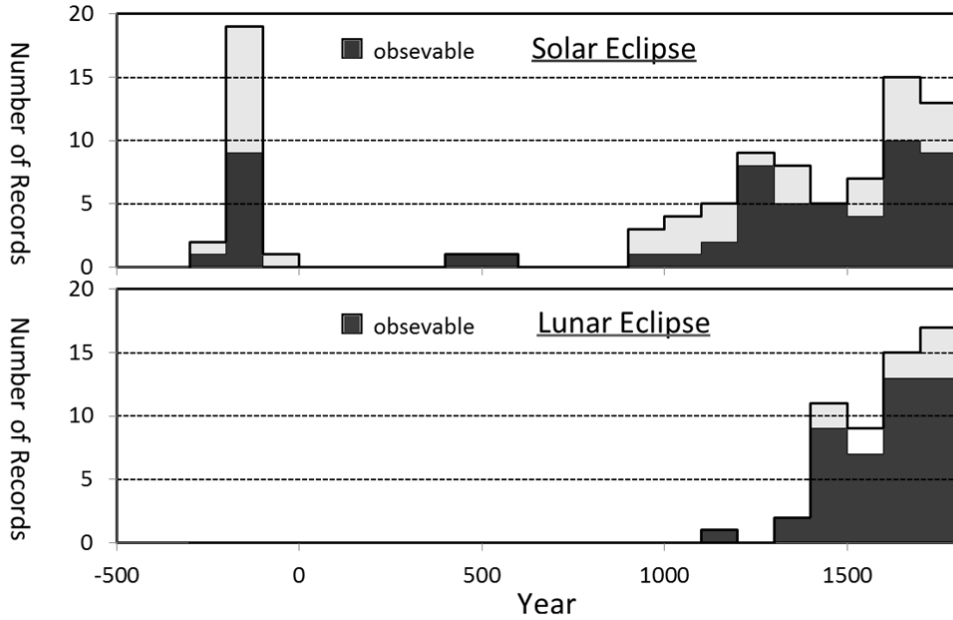


Figure 3: The number of solar and lunar eclipse records in every 100 years

We compare these eclipse records with the results of eclipse simulations using a software developed by Takesako (<http://www.kotenmon.com/star/lmap/index.html>). We found that 45 of 69 solar eclipses (reliability $\sim 65\%$) and 44 of 55 lunar eclipses (reliability $\sim 80\%$) were observable in Hanoi on the described date.

Table 2 shows the reliability of the records for each period divided on the basis of Vietnamese old calendar system (see Table 1). We see from the table that the reliability of the records of solar eclipse for periods (3) through (5) and of lunar eclipse for periods (3) through (4) is almost stable. We keep in mind that the numbers of records of solar eclipse in period (2) and of lunar eclipse in period (3) are too small to calculate significant reliability. Thus, it is likely that the reliability of both eclipse records was not affected significantly by the change of the calendar system between periods (3) and (4), or around AD1300. This is an interesting fact from the viewpoint of whether records were based on observation or prediction (see subsection 4.2).

Table 2: Reliability of solar and lunar eclipse records in and after 10th century

Period	Solar Eclipse Records			Lunar Eclipse Records		
	Records	Observable	Reliability	Records	Observable	Reliability
(2) \sim AD 939– \sim 1078	6	2	33%	–	–	–
(3) \sim AD1080– \sim 1300	15	10	67%	1	0	–
(4) \sim AD1306– 1644	26	18	69%	35	29	83%
(5) AD1645– 1812	22	15	68%	19	15	79%

Among these eclipse records in and after 10th century, there are a few which strongly suggest that Vietnamese records are original. For example, for the solar eclipse occurred on April 30, AD1669, while Chinese text *Qingshi gao* (清史稿) says “4th month, 1st day, there was a solar eclipse of magnitude 5.5/15 (四月...

朔, ... 日食五分半)”, TT says “4th month, 1st day, there was a total solar eclipse (四月朔, 日食既).” According to simulated calculation, the magnitudes of the eclipse observed in Beijing and Hanoi were almost exactly as described in both the historical sources

As will be mentioned in subsection 4.2, there are several eclipse records in TT which gives strong evidence that Vietnamese royal astronomers actually made eclipse prediction in 15th and 16th centuries. Moreover, as will be mentioned in subsection 4.3, there is a record in AD1188 which suggests that Vietnamese calendar system would probably be different from Chinese one in those days. It may be noted here that luni-solar calendar calculations were strongly linked with solar and lunar eclipse predictions.

Thus, we suggest that the solar and lunar eclipse records in and after 10 century would be originally written by Vietnamese royal astronomers.

4.1.3. Lunar eclipse records

Now we consider eight lunar eclipse records for which the occurrence time is given. Among them, six records give the time which is roughly consistent with the simulated calculation results. Two records give the time a few hours earlier than the simulated calculation results. Hence, 75% (6/8) of the records are found to describe consistent time for the eclipse.

Next, we consider six lunar eclipse records which tell that their eclipse is “既 (total),” “全分 (of full magnitude)” or “殆盡 (almost exhausted)”. Among them, five records are of actually total eclipse according to the simulated calculation results while one record is of partial eclipse of small magnitude (0.03 at greatest). Thus, 83% (5/6) of the records are of actually total eclipse.

4.2. Observaton or prediction

Saito (1995) suggested, from his analyses of solar and lunar eclipse records in ancient East Asia, that considerable number of these eclipse records would be those predicted based on calendar calculation rather than those actually observed. On the other hand, Zhang Pei-yu (1993) examined Chinese lunar eclipse records from 3rd through 17th century and concluded that most of them would be reliable observation records.

As for the eclipse records of Vietnam in and after 10th century, several of them suggest that royal astronomers made solar and lunar eclipse prediction. For example, a solar eclipse record in AD1527 says “5th month, 1st day, the officer of the Astronomical Bureau dedicated a prediction that there would be a solar eclipse, and (the eclipse) was not seen (五月初一日司天奏日食、不見), Another example is an episode of a royal astronomer in AD1448. The record containing this episode says “8th month..., Thi Hanh (a royal astronomer) dedicated an absurd prediction (to the King) that there would be an eclipse of the Moon in the hour of mao (29:00–31:00) on 16th day of the month..., The eclipse of the Moon was not seen (八月...、時亨妄奏、是月十六日卯時月食、... 月不見食).” According to TT, Thi Hanh was judged by the Imperial Court to have made a serious mistake, and he was dismissed. As a matter of fact, however, a partial eclipse (magnitude 0.09 at greatest) occurred at low altitude ($16^{\circ}-1^{\circ}$) in Hanoi during 28:50–29:55, as predicted almost exactly by Thi Hanh.

There are a few other records which are clearly not observations: "There was an eclipse of the Sun. It rained. (日蝕, 天雨)", "There was an eclipse of the Moon. It rained heavily. (月食, 天大雨)", "There was an eclipse of the Moon. It was rainy, windy and dark. (The eclipse) was not seen. (月食, 適風雨晦冥不見)."

As for many other records, however, it is difficult to distinguish between observation and prediction because they give no information except the fact there was an eclipse of the Sun or the Moon, from which we cannot judge whether they are observation or prediction.

4.3. Calendar difference between Vietnam and China

As mentioned in section 2, calendar systems in Vietnam and China of those days were not the same in certain periods. For the periods, we should keep in mind that there could exist one lunar month difference between Vietnamese and Chinese calendars due to a different way in allocating an intercalary month in their calendars.

In fact, for the solar eclipse occurred on June 8, AD1732, while Chinese text *Qingchao wenxian tongkao* (清朝文献通考) says “5th month, day renshen, full moon day, the Moon was eclipsed (五月壬申望、月食)”, TT says “intercalary 4th month, full moon day, the Moon was eclipsed. (閏四月望、月食).” According to Lê Thành Lân (2007), an intercalary month was allocated between 4th and 5th months in Vietnamese calendar of the year and between 5th and 6th months in Chinese one.

We may expect that such one lunar month difference could also occur before AD1544, where Vietnamese calendar has not been reconstructed. In this sense, noted is the solar eclipse record on August 24, AD1188, when Vietnamese calendar system was not the same that used in China (see Table 1). While Chinese text *Songshi* (宋史) says “8th month, day jiazi, 1st day, there was an eclipse of the Sun (八月甲子朔、日食)”, TT says “7th month, day jiazi, 1st day, the Sun was eclipsed. (八月甲子朔、日食).” Since stems and branches specifying the day is identical, it is very likely that this one lunar month difference would be caused by different allocation of an intercalary lunar month in the calendar of the year between the two countries.

4.4. The beginning of a day

Date given in the lunar eclipse records of TT will provide us some idea of the beginning of a day in Vietnam in those days, if we adopt such an approach as employed by Zhang Pei-yu (1993) and Ahn and Park (2004), who made use of historical lunar eclipse records in their studies. For this purpose, we concentrate on 30 lunar eclipse records where date is specified by day number of the month or by stems and branches.

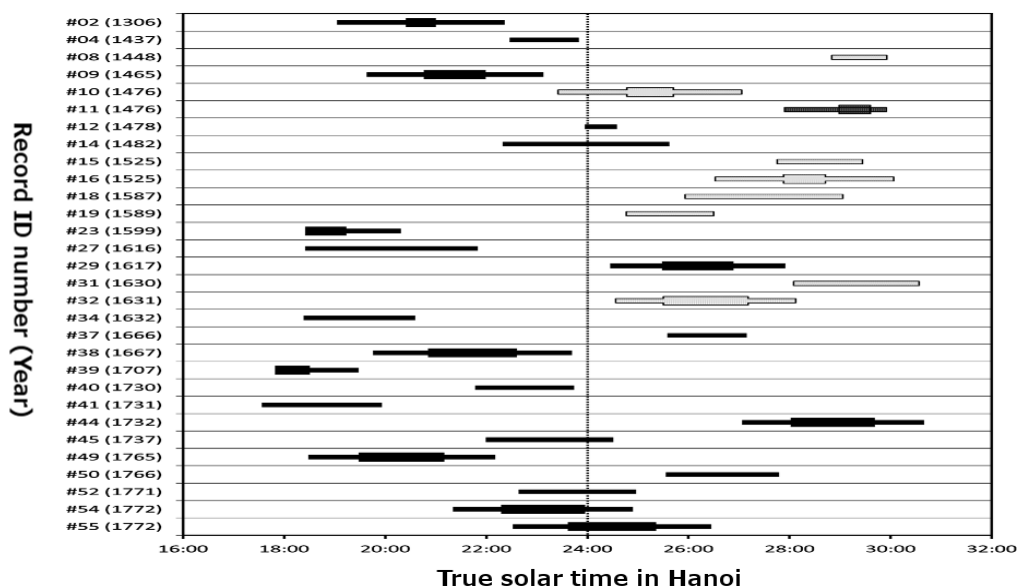


Figure 4: Observable time of 30 lunar eclipse records with the date specified. Narrow bars show partial eclipse time and broad bars total eclipse one. Filled bars show a record dated the same day and shaded bars the following day. True solar time is expressed with the clock of more than 24 hour.

Figure 4, which is contained in Okazaki (2014), illustrates the start and the end time of such 30 lunar eclipses. In the figure, the eclipse records dated the same day as the evening (hereafter, the same day) are shown by filled horizontal bars while those dated the day following the evening (hereafter, the following day) are indicated by shaded bars. As seen in the figure, all the eclipses which ended before midnight are dated the same day. As for those eclipses which started after midnight, however, some of them are dated the same day while the others are dated the following day.

Here, we focus on lunar eclipses before early 17th century (before No.37 in Figure 4). We find that seven of the nine lunar eclipses which started after midnight are dated the following day while two of them (Nos. 11 and 29) the same day. Of the latter two, No.11 describes its eclipse time with the five night watch system. It is noted that, in this time keeping system, time was counted successively all through the night, so that the system should be incompatible with a date change midway through the night. Thus No.11 should be regarded as a particular case. On the other hand, we have no such reasonable explanation for the use of the same day in record No.29. Then, we find that 88% (7/8) of these eclipses are dated the following day, excluding No.11.

Before No.37, there are also three eclipses which started before midnight and ran over midnight, and one of them is dated the following day. On the other hand, from early 17th century (from No.37), all eclipses which started after midnight (three) and which ran over midnight (four) are dated the same day.

We have to keep in mind one thing here. Our discussion about the beginning of a day is based substantially on the records of the lunar eclipses which started after midnight. This means that we are dealing with the period from mid-15th century (No.8) through mid-18th century (No.50), as seen in Figure 4.

In conclusion, we suggest that the beginning of a day would be midnight until early 17th century and dawn afterwards in Vietnam as far as the period from mid-15th through mid-18th century is concerned.

4.5. Solar eclipse records in another historical source

There is another important Vietnamese historical source, which contains some astronomical records from 16th through 18th century. It is *Dại Nam Thực Lục Thiên biên*, or the Early Volumes of *Dại Nam Thực Lục* (DNTL, 大南寔錄 *the True Record of the Great South*). DNTL is the annual records of the Nguyễn Dynasty, which ruled Vietnam from the early 19th to the early 20th century. The Early Volumes of DNTL describe the history of the Nguyễn Lords (阮氏) from the middle 16th to the late 18th century, whose descendants later established Nguyễn Dynasty.

In this period, Vietnamese Lê dynasty (黎朝) has no power, and Nguyễn Lords controlled the South while Trịnh Lords (鄭氏) controlled the North through Lê dynasty. TT is the official history compiled by the latter Lords. It is believed that these two lords have their own calendars calculated by themselves in those days on the basis of Chinese calendar rules.

Since calendars of those days usually presented the dates of the solar eclipses to be seen in their country, and since a solar eclipse prediction was one of the sophisticated techniques in the calendar calculations, the accuracy of these predictions would give us some idea how properly these calendars have been calculated. From the viewpoint that considerable number of the solar eclipse records in DNTL and TT may be prediction results rather than observational ones, we compare solar eclipse records in DNTL and TT.

We found 29 solar eclipse records in DNTL (the Early Volumes). It is noted that there are 32 solar eclipse records in TT for the period covered by both the sources (AD1587–1774) and that four of them are common with those in DNTL.

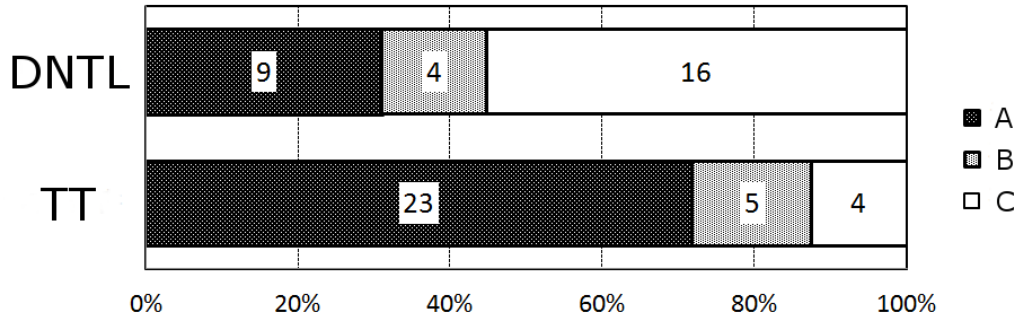


Figure 5: Solar Eclipse Records in DNTL and TT for the overlapping period. A: Observable in Hanoi, B: Not observable in Hanoi though observable somewhere else, C: Not observable anywhere. See text.

As seen in Figure 5, 20 records (69%) in DNTL are incorrect and 16 of them are serious giving wrong lunar months while 9 (28%) records in TT are incorrect and 4 of them are serious. All the incorrect records in DNTL are found in the limited period from the late 17th through the early 18th century, though those in TT are rather randomly distributed.

We also found from our survey of calendars in Lê Thành Lân’s (2007) table that most differences in allocating intercalary month between the calendars used in both the lords are also concentrated in this limited period. Therefore, we suggest that Nguyễn Lord’s calendar calculation (linked with solar eclipse records in DNTL) would have been made less accurately than Trịnh Lords’ calendar calculation in this limited period.

5. Summary

We described the results of our survey of solar and lunar eclipse records from ancient times through 18th century in two important Vietnamese historical source TT and VSL.

We found 92 solar eclipse records and 55 lunar eclipse ones. We also found 29 solar eclipse records (7 of them are common with those in TT) in another historical source DNTL (the Early Volumes). We examined these records by comparing with simulated calculation results and our conclusions are summarized as follows:

- (1) We suggest that the solar and lunar eclipse records in and after 10 century would be originally written by Vietnamese royal astronomers, though those of BC era would have been copied from Chinese text *Hanshu*.
- (2) Although there are several records which are considered to be prediction, many other records cannot be judged whether they are prediction or observation.
- (3) One of the solar eclipse records in the period where Vietnamese calendar has not been constructed gives the occurrence date different by one lunar month from that given by a corresponding Chinese record, which may be explained by difference of the calendar systems used in both countries.
- (4) We suggest that the beginning of a day in Vietnam would be midnight until early 17th century and after that dawn as far as the period from mid-15th through mid-18th century is concerned.
- (5) We suggest that Nguyễn Lord’s calendar calculation (linked with solar eclipse records in DNTL) would have been made less accurately than Trịnh Lords’ calendar calculation in this limited period.

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