

Solar Eclipse Records in the Vietnamese Historical Source *Đại Nam Thực Lục (The Main Part)*

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Abstract

We present the results of our survey of solar eclipse records in the Main Part of *Đại Nam Thực Lục* (ĐNTL), which is the official annals of the Nguyễn dynasty, the last dynasty of Vietnam. We found 31 solar eclipse records for the period from 1778 through 1888. We examine these eclipse records by comparing with astronomical simulation results and found that 82% of them are reliable, i.e., 82% of these eclipses were observable in the capital (Huế). This reliability is much higher than that (31%) in the Early Part of ĐNTL. We also discuss a possible relation between these eclipse records and Vietnamese luni-solar calendar making methods.

1. Introduction

Some historical sources in Vietnam, which are written in classical Chinese, include a considerable number of astronomical records, as those in China, Korea and Japan do. For example, Ho Peng-Yoke (1964) and Okazaki and Yokoo (1984) found astronomical records in *Đại Việt Sử Ký Toàn Thư* (TT, 大越史記全書, Complete Annals of Great Vietnam) and *Việt Sử Lược* (VSL, 越史略, Abridged Chronicles of Vietnam), respectively.

Đại Nam Thực Lục (ĐNTL, 大南寔錄, True Record of the Great South) to be surveyed in this study is another important historical source in Vietnam. This is the official annals of the Nguyễn dynasty, which is the last dynasty, ruling Vietnam from 1802 through 1945. ĐNTL consists of the Early Part (or the Early Volumes, 前編) and the Main Part (or the Main Volumes, 正編).

The Early Part is the annals of the Nguyễn lords, who ruled the southern part of Vietnam from the mid-16th century through the late 19th century in the period of the later Lê dynasty. Their descendants established the Nguyễn dynasty later on. We studied 29 solar eclipse records found in the Early Part. The results of the study was presented at this meeting last year. For more details, refer to Okazaki (2018).

On the other hand, the Main Part is the annals of the Nguyễn dynasty from 1778 (before 1802 when the dynasty started ruling Vietnam) through 1925. It is reported that the annals from 1889 to 1925 have been missing since 1963. Thus our survey of solar eclipse records in the Main Part are limited to the period from 1778 through 1888. Although Vietnam became a protectorate of France from 1885, the Nguyễn dynasty continued their own activity including solar eclipse records and luni-solar calendar calculation.

In this study, we present solar eclipse records found in the Main Part of ĐNTL and examine these records by comparing with astronomical simulation results. We also discuss a possible relation between these eclipse records and Vietnamese old calendar making methods from the

viewpoint that many of solar eclipse records in historical sources would be of prediction. For more details, refer also to Okazaki (2018).

2. The Vietnamese luni-solar calendar

Before dealing with solar eclipse records in the Main Part of ĐNTL, we will mention the luni-solar calendar that was used by the Nguyễn dynasty. Until 1812, the Nguyễn dynasty had used *Vạn Toàn* calendar (萬全曆) that was calculated by Vietnamese royal astronomers with Chinese Datong method. This calendar was also used by the Nguyễn lords from the mid-16th century through the late 19th century. In January 3, 1813, the Nguyen dynasty introduced *Hiệp Kỷ* (協紀曆) calendar that was calculated again by Vietnamese royal astronomers with Chinese *Shixian* method. Lê Thành Lân (2003) restored *Vạn Toàn* calendar up to 1631.

Lê Thành Lân (2007) published *Conversion Table between Solar (Julian/Gregorian) Calendars and Vietnamese / Chinese Lunar (Luni-solar) Calendars for 2030 Years (AD0001--2030)*, which contains *Vạn Toàn* calendar from 1631 to 1812 and *Hiệp Kỷ* calendar from 1813. We use this table to convert the dates appearing in solar eclipse records in ĐNTL.

We briefly mention Vietnamese luni-solar calendars from the early 10th century through the late 19th century for the later discussion. Hoàng Xuân Hãn (1982) and Lê Thành Lân and Nguyễn Thị Trường (2017) investigated a relation between Vietnamese and Chinese luni-solar calendars. Based on their conclusions, Okazaki (2018) divided the period he surveyed into four phases as follows:

Phase (a)	939 – 1080	Chinese calendars were probably used.
Phase (b)	1081 – 1300	Calendar making method is unknown (not same as used in China of the same time)
Phase (c)	1301 – 1812	Vietnamese astronomers calculated their calendars using Chinese Shoushi / Datong method.
Phase (d)	1813 – 1888	Vietnamese astronomers calculated their calendars using Chinese Shixian method.

3. Survey results

From our survey, we found 31 solar eclipse records in the Main Part of ĐNTL. They are listed in Table 1.

The first column is the sequential number of the record. The second column yields the original texts of individual records. Although no English translations are given here, most of the records provide the date and the words “日有食之” or “日食” ([there was] an eclipse of the sun) only. We will show a few examples of English translation in the subsection 4.1.

The third column gives the dates of the recorded eclipse that are converted from Vietnamese calendar into Julian/Gregorian calendar in yyyy.mm.dd format. As mentioned above, the conversion was made according to Lê Thành Lân's (2007) table.

The fourth column shows whether the eclipse was observable or not in the capital (Huế): “Yes or No” is based on the results of the solar eclipse simulated calculation, for which we use *Solar Eclipse Explorer* (Espenak and O'Byrne, n.d.) and also *Emap* (Takesako, n.d.). We found that the results obtained with these two methods are in good agreement for solar eclipses in the 19th century: no difference in the magnitude at mid-eclipse of the third place of decimal. As for the records for that Yes is given, we call them *reliable* ones in this study. There is one record (No.23) for that Yes/No is given, This record is regarded as marginally reliable because the first sentence is correct while the second incorrect (see subsection 4.1).

Table 1 Solar eclipse records found in the Main Part of ĐNTL

No.	Original Text	Date <i>yyyy.mm.dd</i>	Observable in Huế?	Remarks
1	嘉隆元年 八月己亥朔日有食之	1802.08.28	Yes	
2	嘉隆六年 五月壬寅朔日有食之	1807.06.06	Yes	No records in China
3	嘉隆九年 三月乙卯朔日有食之	1810.04.04	Yes	No records in China
4	嘉隆十二年 春正月己巳朔日有食之	1813.02.01	No	
5	嘉隆十三年 六月庚申朔日有食之	1814.07.17	Yes	
6	嘉隆十六年 夏四月甲戌朔日有食之	1817.05.16	Yes	
7	嘉隆十六年 冬十月辛未朔日有食之	1817.11.09	Yes	
8	明命二年 二月壬午朔日有食之	1821.03.04	Yes	
9	明命五年 六月癸巳朔日有食之	1824.06.27	Yes	
10	明命九年 春三月庚子朔日有食之	1828.04.14	Yes	
11	明命九年 秋九月戊戌朔日有食之	1828.10.09	Yes	
12	明命二十一年 春二月壬戌朔日有食之	1840.03.04	Yes	
13	紹治二年 夏六月戊寅朔日有食之	1842.07.08	Yes	
14	紹治三年 十一月己巳朔日有食之	1843.12.21	Yes	
15	紹治七年 秋九月丁丑朔日有食之	1847.10.09	Yes	
16	嗣德二年 二月庚子朔日有食之	1849.02.23	Yes	
17	嗣德三年 春正月甲午朔日有食之	1850.02.12	Yes	
18	嗣德五年 十一月丁未朔日有食之	1852.12.11	Yes	
19	嗣德十年 八月朔己酉日食	1857.09.18	Yes	
20	嗣德十四年 六月戊午朔日食	1861.07.08	Yes	
21	嗣德十五年 十一月己酉朔日食	1862.12.21	Yes	
22	嗣德十七年 二月壬申朔日食	1864.03.08	No	Serious error
23	嗣德十七年 夏四月辛未朔日食	1864.05.06	Yes	
24	嗣德二十一年 秋七月丙子朔日食	1868.08.18	Yes	
25	嗣德二十四年 十一月丁亥朔日食	1871.12.12	Yes	No records in China
26	嗣德二十八年 三月戊戌日食	1875.04.06	Yes	
27	嗣德三十二年 十二月庚子日食	1880.01.12	No	No records in China
28	嗣德三十五年 二月丁巳日食	1882.03.19	No	Serious error
29	嗣德三十五年 夏四月丙辰朔日食 改以丁巳初二日	1882.05.17/18	Yes/No	
30	同慶元年 二月朔乙丑日有食之	1886.03.06	No	No records in China
31	同慶二年 七月丙辰朔日有食之	1887.08.19	Yes	

The fifth column contains remarks: “No records in China” means that no records of the eclipse have been found in the Qing dynasty’s documents (*Qingshigao* 清史稿, etc.) or local chronicles in China. By “serious error” we mean the case in which a solar eclipse occurred nowhere on the earth in the month assigned in the record but somewhere 1–3 month(s) earlier or later.

4. Discussion

4.1 Two records of a serious error

Nos. 22 and 28 are records of a serious error. It is noticed that each of them mention the eclipse occurring only two lunar months before the date of the eclipse given in each next records (Nos. 23 and 29, respectively). Keeping in mind that solar eclipses cannot occur with only 2 lunar month difference, we examine some relation between such record pairs with 2 lunar month difference.

Nos.28 and 29 is one of the pairs: No.28 says “35th year in the Tự Đức reign period (1882), 2nd month, day *đinh-tỵ* (丁巳), there was an eclipse of the sun.” while No.29 says “35th year in the Tự Đức reign period (1882), summer, 4th month, day *bính-thìn* (丙辰), the 1st day of the month, there was an eclipse of the sun. The date should be replaced by ‘day *đinh-tỵ* (丁巳), the 2nd day of the month’.” In view of the similarity in shape between the Chinese characters “二月” (2nd month) in No.28 and “二日” (2nd day) in No.29, it is probable that the record No.28 would happen to have arisen from the second sentence of No.29 due to some inaccurate compilation process. Our simulation results show the first sentence is correct rather than the latter.

Another pair of records (Nos.22 and 23) might also be explained in a similar way: No.22 says “17th year in the Tự Đức reign period (1864), 2nd month, day *nhâm-thân* (壬申), there was an eclipse of the sun.” while No.23 says “17th year in the Tự Đức reign period (1864), summer, 4th month, day *nhâm-thân* (辛未), the 1st day of the month, there was an eclipse of the sun, summer.” It is noticed that, in the 4th month of that year, the 2nd day is day *nhâm-thân* (壬申). Although this reminds us of the above case of Nos.28 and 29, we have no other evidence to suggest some relation between Nos.22 and 23: for example, there does not exist such a second sentence in No.23, as found in No.29

4.2 Reliability of the records

In this study, the *reliability* is defined as a ratio of the number of records of the eclipse observable in the capital (Hue) to the total number of the eclipse records. We found that 25.5 of 31 (reliability:82%) solar eclipses mentioned in the Main Part of ĐNTL were observable in the capital on the date given in the record (Note: No.29 is counted as 0.5 reliable records. See subsection 4.1). Moreover, among doubtful (unreliable) records, 2 records (Nos. 22 and 28) are of a serious error..

It is interesting to compare the reliability of the eclipse records between the Main Part and the Early Part. As shown in Table 2, the reliability in the Early Part is much lower than that in the Main Part. We suggested that such extremely low reliability in the Early Part would be connected with improper calculations of luni-solar calendar for the period from ~1670 (possibly up to ~1630) to ~1720 from the viewpoint that most of the solar eclipse records would be of prediction. See Okazaki (2018) for more details.

Table 2 The Reliability of Solar Eclipse Records in ĐNTL

ĐNTL	Total records	Observable	Reliability
Main Part	31	25.5	82%
Early Part	29	9	31%

4.3 Solar eclipse record reliability vs luni-solar calendar making method

Now, from the above-mentioned viewpoint that many eclipse records would be of prediction, we extend the period up to the early 10th century for our discussion on the reliability data of the solar eclipse records. For the reliability prior to the period covered by the Main Part of ĐNTL, we use solar eclipse records in TT and VSL investigated by Okazaki (2018) and not use those in the Early Part of ĐNTL because of their extremely low reliability as mentioned in the last subsection.

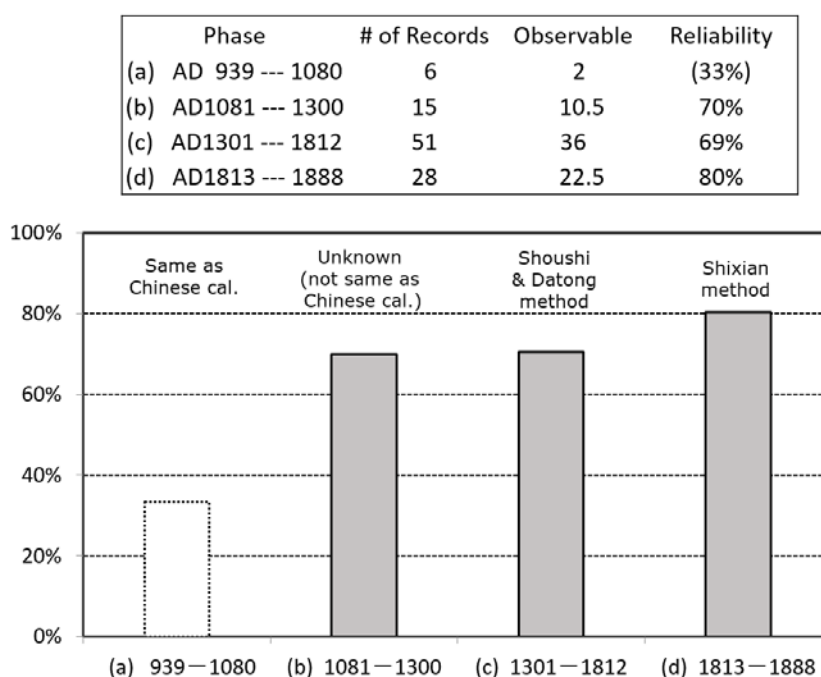


Figure 1 The reliability of solar eclipse records vs luni-calendar calendar making method. See section 2 for explanation phases (a) – (d).

Figure 1 shows the reliability of eclipse records against the phase, which is determined by what calendar making methods are used in Vietnam at that time. Excluding phase (a) where the number of data is too few for statistics, we see that the reliability for phase (d) is rather higher than that for phases (b) and (c). A more careful examination is necessary to determine whether this tendency is significant or not. See Okazaki (2018) for more details.

5. Summary

- We found 31 solar eclipse records in the Main Part of ĐNTL. Among them, 25.5 records (reliability:82%) are of the eclipse observable in the capital on the given date.
- The reliability of solar eclipse records in the Main Part is much higher than that in the Early Part.
- Concerning the reliability against the phase, which is determined by what calendar making methods are used in Vietnam at that time, the reliability for phase (d) seems rather higher than that for phases (b) and (c). A more careful examination is necessary, however, to determine whether this tendency is significant or not.

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