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THE CHRONOLOGY OF WESTERN ZHOU

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Abstract

By systematically analyzing the relative relationship between complete bronze inscription dates, this study deduces the lunar phases described by the specialized terms *jishengba* 既生霸, *jiwang* 既望, and *jisiba* 既死霸, finding that the term *chuji* 初吉 is unrelated to the lunar phase. The study then reconstructs a complete chronology of Western Zhou that is highly consistent with archaeological and textual evidence. The results support the traditional notion that the Zhou calendar year began in the month containing the winter solstice, and show that the Western Zhou calendar month began with the first invisibility of the waning lunar crescent while the calendar day began at sunrise. The overall evidence indicates that King Wu 武王 led an initial campaign against the Shang in 1046 B.C.E. and defeated Zhòu 紂 in 1044 B.C.E., lending credence to the narrative of the military display at Mengjin (觀兵孟津). The derived chronology reveals a previously unknown seven-year gap between King You's 幽王 final year and King Ping's 平王 first year, thus explaining the discrepancies between *Shi ji* 史記 and the archaeological evidence. This study demonstrates that the Modern Text (*jinben* 今本) *Bamboo Annals* 竹書紀年 is unsuitable for use in chronological studies, and suggests that the dates of Western Zhou were already obscure in Eastern Zhou. These results provide testable hypotheses and raise new questions that can guide further research into Western Zhou archaeology, history, society, and culture.

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The generally accepted chronology of Chinese history begins abruptly in the late stages of Western Zhou with the start of the Gonghe 共和 regency in 841 B.C.E. Establishing the absolute dates of earlier events has become a classical problem that remains unresolved. The first known attempt was made by the Western Han scholar Liu Xin 劉歆, who established the method of computing absolute dates based on the *ganzhi* 干支 day count and the lunar phase. However, the traditional method relied on calendrical calculations with limited accuracy, often deviating considerably from the true lunar phase. Moreover, Liu Xin and other pre-modern scholars depended on texts whose reliability is difficult to establish. Therefore, little progress was made before the modern era.

In the early twentieth century, Shinjō Shinzō 新城新藏 improved calculation accuracy by applying modern astronomical methods. Shinjō also realized that complete inscription dates on excavated Western Zhou bronzes were reliable contemporaneous records, and he pioneered efforts to use these dates to reconstruct a complete chronology of Western Zhou.

Complete inscription dates consist of four components: the year, the month, the day, and a specialized term widely believed to describe the lunar phase. The year is given as the regnal year of the ruling monarch, who almost always remains unidentified. The month is given as the ordinal month of a lunisolar calendar whose key characteristics (the starting points of the year, month, and day, as well as the rules governing intercalation) are unknown. The day is given as a day in the *ganzhi* cycle, with the *ganzhi* day count assumed to be continuous down to modern times. The specialized term is one of *chuji* 初吉, *jishengba* 既生霸, *jiwang* 既望, or *jisiba* 既死霸. The precise lunar phase described by each term is unknown, and some even question whether *chuji* describes the lunar phase at all. In summary, three out of the four components of complete inscription dates are unknown.

Due to this lack of information, chronological reconstruction must rely on a set of a priori assumptions, and different assumptions have led to conflicting results.[1] The Xia-Shang-Zhou Chronology Project

1. For a summary of reconstructions up to 1991, see Edward L. Shaughnessy, *Sources of Western Zhou History: Inscribed Bronze Vessels* (Berkeley: University of California Press, 1991), 237–38. For Shaughnessy's own reconstruction, see ibid., xix, 217–87. For notable reconstructions after 1991, see Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben* 夏商周斷代工程 1996—2000 年階段成果報告：簡本 (Beijing: Shijie tushu, 2000); Liu Qiyi 劉啓益, *Xi-Zhou jinian* 西周紀年 (Guangzhou: Guangdong jiaoyu, 2002); Wang

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夏商周斷代工程 (Chronology Project) sought to compensate for this lack of information by using archaeological and radiocarbon dating methods. However, both dating methods lack the precision to build a year-by-year chronology, and the Chronology Project's reconstruction attempt was ultimately unsuccessful.[2] Chronological reconstruction cannot succeed without the ability to derive accurate dates from complete inscription dates, and this requires knowledge of the lunar phases described by the specialized terms.

Although many interpretations of the terms have been proposed, few have been rigorously tested, due to technical limitations. The conventional approach attempts to infer the meanings of the specialized terms through direct computation of the lunar phase. However, this method requires prior knowledge of the absolute dates of Western Zhou—the unknown that we seek to reconstruct.[3] This conventional approach is thus fundamentally inadequate to deduce the meanings of the terms.[4]

To overcome this methodological shortcoming, this study develops a novel strategy to deduce the meanings of the specialized terms without prior knowledge of the absolute dates of Western Zhou. This approach enables the various interpretations of the terms to be rigorously tested against empirical evidence, revealing the proper meanings of the specialized terms as well as key features of the Western Zhou calendar. Accurate understanding of the specialized terms enabled the successful derivation of a complete chronology of Western Zhou that is highly consistent with archaeological and textual evidence. The results provide new insights into the Chinese textual heritage, with broad implications for the study of Western Zhou archaeology, history, society, and culture.

Zhankui 王占奎, "Xi-Zhou liewang jinian nice" 西周列王紀年擬測, *Kaogu yu wenwu* 考古與文物 2003.3, 17–30; David S. Nivison, *The Riddle of the Bamboo Annals* (Taipei: Airiti, 2009); and Chen Jiujin 陳久金, "Dui Xi-Zhou zhuwang wangnian de zuizhong xiuzheng yijian" 對西周諸王王年的最終修正意見, *Guangxi minzu daxue xuebao* 廣西民族大學學報 23.1 (2017), 9–23.

2. Recent discoveries have essentially refuted the chronology of Western Zhou proposed by the Chronology Project, see Zhu Fenghan 朱鳳瀚, "Yaogong gui yu Tangbo houyu Jin" 覗公簋與唐伯侯於晉, *Kaogu* 考古 2007.3, 64–69.

3. Although *Shi ji* 史記 provides the absolute dates of Kings Xuan 宣王 and You 幽王, it is not known which inscription dates belong in their reigns. Moreover, as will be discussed later, recent evidence shows that the partial chronology of Western Zhou in *Shi ji* is inaccurate.

4. For more in-depth criticism of the conventional method, see David W. Pankenier, "Reflections of the Lunar Aspect on Western Chou Chronology," *T'oung Pao* 78.1 (1992), 33–76.

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Deciphering the Specialized Terms

Methodology

RATIONALE

Without knowledge of the absolute dates of Western Zhou, this study analyzes the relative relationship between complete inscription dates. The time interval between two complete inscription dates limits the lunar phase relationship between them. If the specialized terms of the dates satisfy the lunar phase relationship, then the dates are compatible, if not, then they are incompatible. Importantly, without knowledge of the length of each reign, the time interval between two dates can only be calculated under the assumption that they are from the same reign. Therefore, compatibility provides key information about whether dates can be placed in the same reign: dates belonging to the same reign must be compatible, whereas dates that are incompatible cannot be placed in the same reign.

Any number of inscription dates that are mutually compatible can be grouped together, and the resulting compatibility group represents a hypothetical reign containing all dates within the group. The total number of groups required to account for all complete inscription dates depends on how the specialized terms are interpreted. But regardless of how the terms are understood, the total number of compatibility groups cannot exceed the total number of Western Zhou kings, for there cannot be more reigns than there are kings.[5]

The total number of Western Zhou kings is known with certainty and is independent of the absolute dates of Western Zhou. Therefore, if certain interpretations of the specialized terms fail to accommodate all complete inscription dates within the permitted number of compatibility groups, these interpretations can be confidently rejected as incorrect.

METHOD

A four-step process was employed to simultaneously analyze the compatibility of multiple inscription dates. First, the datetimes of the lunar conjunctions, oppositions, and quadratures, as well as the twenty-four solar terms were calculated using the positional data and orbital parameters from the DE431 ephemeris published by the Jet Propulsion

5. This assumes the following: a) each king established only one calendar, b) there were no additional claimants to the throne beyond the recorded kings, and c) inscription dates on Western Zhou bronzes are all from the royal Zhou calendar. It is possible that separate year counts were established during the regencies of the Duke of Zhou 周公 and Gonghe. This would allow two more "reigns" than the total number of kings.

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Laboratory,[6] utilizing the routines provided in the Skyfield package for Python.[7] Calculation results were validated against previously published data.[8]

Next, a reference calendar was constructed to approximate the historical Western Zhou calendar (Table S1, all times are Xi'an local time [meridian 108° 56′ 23.3″ E]). To simplify calculations, the calendar day was assumed to begin at midnight, the calendar month was assumed to start on the day of the new moon (*shuo* 朔), and the calendar year was assumed to begin with the month containing the winter solstice (month of *zi* 子). Where necessary, intercalary months were appended to the end of the year.

Subsequently, for each complete inscription date, the reference calendar was exhaustively searched for all absolute dates that agree with the month and *ganzhi*, as well as the lunar phase inferred from the specialized term. Search results must match the *ganzhi* exactly, whereas search criteria for the month and lunar phase were relaxed to account for likely differences between the reference calendar and the historical Western Zhou calendar: search results were allowed to deviate up to one month from the month specified by the inscription date,[9] and allowed to deviate no more than one day from the lunar phase inferred from the inscription date (see Supplementary Text for more details).

Finally, using the regnal year of the inscription date, all search results are converted to their corresponding *yuan*,[10] which mark the starting years of all hypothetical reigns that can accommodate the relevant complete inscription date. The corresponding *yuan* of an inscription date are referred to as its "solutions." Inscription dates that have common solutions are mutually compatible, with their common solutions being the *yuan* of the hypothetical reigns that contain the dates.[11]

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6. William M. Folkner, James G. Williams, Dale H. Boggs, Ryan S. Park, and Petr Kuchynka, "The Planetary and Lunar Ephemerides DE430 and DE431," *IPN Progress Report* 42-196 (2014), 1–81.

7. Brandon Rhodes, "Skyfield: High Precision Research-Grade Positions for Planets and Earth Satellites Generator," *Astrophysics Source Code Library*, ascl:1907.024 (2019), version 1.34.

8. Calculations were done for the years 1151–700 B.C.E. Results for lunar conjunctions and oppositions were validated against Zhang Peiyu 張培瑜, "Heshuo manyue biao" 合朔滿月表, in *Sanqianwubai nian liri tianxiang* 三千五百年曆日天象 (Zhengzhou: Daxiang, 1997), 439–884. Results for the winter solstices were validated against Zhang Peiyu, "Fenzhi bajie biao" 分至八節表, *Sanqianwubai nian liri tianxiang*, 885–957. Zhang Peiyu used China Standard Time for his calculations, which is slightly over forty-four minutes ahead of Xi'an local time.

9. This in effect assumes the historical Western Zhou calendar year always started within one lunar month of the month of *zi*.

10. In this study, *yuan* refers to the first year (*yuannian* 元年).

11. Note that compatible dates can still be placed in separate reigns.

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Although previous studies had examined the relative lunar phase between bronze inscription dates,[12] the procedure outlined above provides the absolute dates of possible solutions, and offers an intuitive way to simultaneously analyze the compatibility of multiple dates.

THE EVIDENCE

Excavated bronze inscriptions are reliable contemporaneous records and serve as the primary evidence for this study. Appendix A lists the inscriptions considered in this study, including all complete inscription dates (nos. 1–76) and incomplete inscription dates recording a regnal year (nos. 77–107), from bronzes published as of July, 2016. Appendix A also includes select inscriptions that provide helpful information (nos. 108–120). Henceforth, inscriptions will be referenced by their number in Appendix A.

Apart from using the *ganzhi* and lunar phase information of complete inscription dates to compute absolute dates, this study also considers auxiliary information inferred from the vessels and their inscriptions. Vessel shape and decor, calligraphy style, and inscription content provide an estimate of age, setting approximate bounds for the absolute dates of the vessels.[13] Some vessels mention the same individuals in their inscriptions, which limits the chronological distance between them. Certain vessels belong to separate donors from different generations of the same lineage, which defines their chronological order. In rare cases, inscriptions explicitly identify one or more Zhou kings, either as the recipient of sacrifice or as the ruling monarch, thus providing clues to which reigns the vessels may belong to.

Unlike with bronze inscriptions, errors, distortions, or outright forgery might have occurred during the compilation or transmission of texts,

12. Ma Chengyuan 馬承源, "Xi-Zhou jinwen he Zhouli de yanjiu" 西周金文和周曆的研究, *Shanghai bowuguan jikan* 上海博物館集刊 2 (1982), 26–61; Xu Fengxian 徐鳳先, "Using Sequential Relations of Day-Dates to Determine the Temporal Scope of Western Zhou Lunar Phase Terms," trans. David W. Pankenier, *Early China* 33–34 (2010–11), 171–98; Asahara Tatsurō 淺原達郎, "Sei-Shū kinbun to reki" 西周金文と曆, *Tōhō gakuhō* 東方學報 58 (1986), 71–120. Ma Chengyuan's approach could only analyze the relative compatibility of two dates at a time, making the comparison between multiple dates extremely tedious. Xu Fengxian took a similar approach to Ma Chengyuan, but limited her analysis to a select few dates. Asahara developed a more general approach that is independent of the underlying calendar and allows simultaneous analysis of multiple dates. However, it is difficult to analyze the compatibility of inscription dates that contain different specialized terms using Asahara's approach.

13. It is possible that vessels from later periods emulated earlier styles, which would allow placement of vessels with earlier style in later periods. This study assumes that this phenomenon did not occur, thus placing stricter temporal restrictions on the vessels.

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making them less reliable in general. Therefore, texts serve as secondary evidence and are only considered when the primary evidence cannot produce unique solutions. Texts that contradict archaeological evidence are disregarded.

The "Wu cheng" 武成, "Shao gao" 召誥, and "Bi ming feng xing" 畢命豐刑 chapters of *Shang shu* 尚書, as quoted in *Han shu* 漢書,[14] as well as the "Shi fu" 世俘 chapter of *Yizhoushu* 逸周書 all contain *ganzhi* and lunar phase information that can be used to compute absolute dates. The quoted chapters in *Han shu* are widely believed to be authentic Western Zhou texts,[15] whereas "Shi fu" is considered the most reliable chapter of *Yizhoushu* based on textual comparisons with oracle bone and bronze inscriptions.[16] Therefore, these texts will be considered, along with the pre-Qin history texts *Chun qiu* 春秋, *Zuo zhuan* 左傳, and *Xinian* 繫年 of the Tsinghua bamboo slips 清華簡.

Zhushu jinian 竹書紀年, or the *Bamboo Annals*, was recovered from a looted tomb in the third century C.E. The original work has been lost since the Song dynasty. Late Qing and modern scholars have reconstituted portions of the original text by collecting quotations from pre-Song books. This reconstituted text is known as the Ancient Text (*guben* 古本) version. The Modern Text (*jinben* 今本) version appeared in the Ming dynasty and contains a complete chronology of Western Zhou. There is longstanding debate over the authenticity of both versions.[17] However, even the proponents of the authenticity of the Modern Text version

14. *Han shu* (Beijing: Zhonghua, 1962), 21.1015–17 ("Shi jing" 世經).

15. These texts are often presumed to be authentic, see Shaughnessy, *Sources of Western Zhou History*, 230, 243. However, Pankenier doubts the reliability of the dates of "Wu cheng," whereas Vogelsang has argued that none of the *Shang shu* chapters are authentic, see Pankenier, "Reflections of the Lunar Aspect"; Kai Vogelsang, "Inscriptions and Proclamations: On the Authenticity of the 'Gao' Chapters in the *Book of Documents*," *Bulletin of the Museum of Far Eastern Antiquities* 74 (2002), 138–209.

16. Guo Moruo 郭沫若, *Zhongguo gudai shehui yanjiu* 中國古代社會研究, *Guo Moruo quanji* 郭沫若全集, vol. 1 (Beijing: Renmin, 1982), 299–300; Gu Jiegang 顧頡剛, "'*Yizhoushu*: Shi fu pian' jiaozhu, xieding yu pinglun"《逸周書·世俘篇》校注、寫定與評論, *Wenshi* 2 (1963), 1–41; Edward L. Shaughnessy, "'New' Evidence on the Zhou Conquest," *Early China* 6 (1980–81), 57–79.

17. Wang Guowei 王國維 believed that the Modern Text version is a forgery, see Wang Guowei, *Jinben Zhushu jinian shuzheng* 今本竹書紀年疏證, *Wang Guowei quanji* 王國維全集, vol. 5 (Hangzhou: Zhejiang jiaoyu, 2009), 201; Keightley has argued that the Ancient Text version is unreliable, see David N. Keightley, "The *Bamboo Annals* and Shang-Chou Chronology," *Harvard Journal of Asiatic Studies* 38.2 (1978), 423–38; Pankenier, Nivison, and Shaughnessy have argued that the Modern Text version is authentic, see David W. Pankenier, "Astronomical Dates in Shang and Western Zhou," *Early China* 7 (1981–82), 2–37; David S. Nivison, "The Dates of Western Chou," *Harvard Journal of Asiatic Studies* 43.2 (1983), 481–580; Edward L. Shaughnessy, "On the Authenticity of the *Bamboo Annals*," *Harvard Journal of Asiatic Studies* 46.1 (1986), 149–80. Cheng

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acknowledge that its chronology is inaccurate, therefore the Modern Text *Bamboo Annals* cannot be used for chronological reconstruction. On the other hand, the Ancient Text *Bamboo Annals* contains no known explicit conflicts with bronze inscriptions, in part due to its fragmentary nature. Therefore, this study will consider the Ancient Text version to the extent that it agrees with the archaeological evidence. Future mentions of the *Bamboo Annals* refer to the Ancient Text version unless otherwise specified.

Although *Shi ji* was completed in the Han dynasty, its various chapters preserve pre-Qin material accessible to Sima Qian 司馬遷. This information will be consulted if necessary. As a matter of principle, all evidence is accepted as is, allowing no modification.

A SIMPLIFIED CRITERION

Considering all possible combinations of the eighty complete inscription dates in Appendix A is prohibitively complex. To simplify the problem, the initial analysis focuses on complete inscription dates from the late stage of Western Zhou with high (>20) regnal years.

Late Western Zhou includes the reigns of Kings Li 厲王, Xuan 宣王, and You 幽王, as well as the Gonghe regency, which may have maintained a separate year count. According to *Shi ji*, King Li was expelled from the capital in his thirty-seventh year, the Gonghe regency established its own year count which lasted for fourteen years, King Xuan ruled for forty-six years, and King You ruled for eleven years.[18] The duration of the Gonghe regency as well as the reigns of Kings Xuan and You are also corroborated by other sources: *Xinian* states that the Gonghe regency lasted for fourteen years,[19] whereas *Guo yu* 國語 states that King You ruled for eleven years.[20] The inscription of Lai[21] *pan* 逑盤 (no. 119) places the forty-second and forty-third year Lai *ding* 逑鼎 (nos. 75–76)

Pingshan 程平山 gives a very comprehensive review of this debate in Cheng Pingshan, *Zhushu jinian kao* 竹書紀年考 (Beijing: Zhonghua, 2013), 451–81.

18. *Shi ji* (Beijing: Zhonghua, 2014), 4.180–88, 12.650–70.

19. Li Xueqin 李學勤, ed., *Qinghua daxue cang Zhanguo zhujian (er)* 清華大學藏戰國竹簡（貳）, vol. 2 (Shanghai: Zhongxi, 2011), 138.

20. *Guo yu jijie* 國語集解, ed. Xu Yuangao 徐元誥 (Beijing: Zhonghua, 2002), 27 ("Zhou yu shang" 周語上).

21. The donor's name is variously transcribed as Lai 逑, Qiu 逑, Bi 𢍏, or Su 速. See n. 2 of Edward L. Shaughnessy, "The Writing of a Late Western Zhou Bronze Inscription," *Asiatische Studien = Études Asiatiques* 61.3 (2007), 845–77. In addition to the variants mentioned above, Li Xueqin proposed transcribing the donor's name as Zuo 佐, see Li Xueqin, "Lun Bingong xu jiqi zhongyao yiyi" 論虢公盨及其重要意義, *Zhongguo lishi wenwu* 中國歷史文物 2002.6, 4–12, 89.

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firmly in King Xuan's reign,[22] showing that King Xuan reigned for at least forty-three years. Therefore, only King Xuan's reign, and possibly King Li's reign, can accommodate late Western Zhou inscription dates with high regnal years. Interpretations of the specialized terms that fail to accommodate these dates within two reigns can thus be rejected with high confidence.

A NEW END POINT

The complete inscription dates of Lai *ding* are firmly placed in King Xuan's reign, whose absolute dates are given in *Shi ji*. This offered a rare opportunity to directly probe the meaning of the associated specialized term, *jishengba*, using the absolute dates of Western Zhou. However, *jishengba* was found to be a few days before as well as after *shuo*, which is nonsensical.[23] This result shows that Sima Qian's partial chronology of Western Zhou contradicts archaeological evidence and is thus unreliable.

Previous work all focused on reconstructing dates prior to 841 B.C.E., the first year of the Gonghe regency according to *Shi ji*. The dates of Lai *ding* now force this study to disregard Sima Qian's partial chronology and find a new end point for chronological reconstruction. *Chun qiu* records a solar eclipse in the year of King Ping's 平王 death,[24] which modern astronomical methods date to February 22, 720 B.C.E.[25] This firmly establishes 720 B.C.E. as the year of King Ping's death, and this year is chosen as the end point for chronological reconstruction, thereby including the entirety of Western Zhou as well as King Ping's reign within the scope of reconstruction.

Interpretations of the Specialized Terms

Interpretations of the specialized terms fall into two general categories: fixed-point (*dingdian* 定點), or segmental (*fenduan* 分段). A specific term governs only a day or two in the lunar cycle under fixed-point interpretations, but describes a period of three days or more under segmental

22. Li Xueqin, "Meixian Yangjiacun xinchu qingtongqi yanjiu" 眉縣楊家村新出青銅器研究, *Wenwu* 文物 2003.6, 66–73.

23. Zhang Peiyu, "Laiding de yuexiang jiri he Xi-Zhou niandai" 逨鼎的月相紀日和西周年代, *Wenwu* 2003.6, 78–84.

24. In spring of the third year, in the second month of the royal calendar, on the day *jisi* (6), an eclipse occurred. In the third month, on the day *gengxu* (47), the Celestial King died (三年春, 王二月, 己巳, 日有食之. 三月, 庚戌, 天王崩). See *Chun qiu zuo zhuan zhengyi* 春秋左傳正義 (Beijing: Beijing daxue, 2000), 3.78a–79b (Yin 3).

25. Zhang Peiyu, Chen Meidong 陳美東, Bo Shuren 薄樹人, and Hu Tiezhu 胡鐵珠, *Zhongguo gudai lifa* 中國古代曆法 (Beijing: Zhongguo kexue jishu, 2013), 167–69.

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interpretations. The more broadly the specialized term is interpreted, the more potential solutions will be found. If a broader interpretation cannot produce a reasonable solution, then neither will a narrower interpretation. Therefore, this study prioritizes the analysis of segmental interpretations.

CHUJI IS UNRELATED TO THE LUNAR PHASE

Although their exact meanings are disputed, there is general agreement that *jishengba*, *jiwang*, and *jisiba* describe the lunar phase. However, whether *chuji* describes the lunar phase is a subject of much debate. *Chuji* appears in the poem "Xiao ming" 小明 (Mao 207) from *Shi jing* 詩經: "From *chuji* of the second month [二月初吉] / I have passed through cold and heat [載離寒暑]." Both Mao's commentary (*Mao zhuan* 毛傳) and Zheng's notes (*Zheng jian* 鄭箋) interpret *chuji* as the new moon.[26] However, the Qing scholar Wang Yinzhi 王引之 questioned this interpretation, proposing instead that *chuji* refers to an auspicious day within the first ten days of the lunar month,[27] a view shared by some modern scholars.[28] Under this interpretation, although *chuji* is semantically unrelated to the lunar phase, it is functionally related—*chuji* must be no more than nine days after the lunar phase marking the start of a new calendar month. On the other hand, Wang Guowei argued that *chuji* spanned the seven to eight days from *shuo* to the first quarter (inclusive).[29] Shinjō believed that the Western Zhou calendar month began with the first visibility of the waxing crescent, or *fei* 朏, and thus modified Wang Guowei's interpretations so that *chuji* began on *fei* and ended on the first quarter.[30]

Liu Yu 劉雨 analyzed the frequency of the four specialized terms in bronze inscriptions and found that *chuji* appeared in over 300 inscriptions throughout Western and Eastern Zhou, whereas the remaining three terms totaled only 114 appearances, of which 110 were in Western Zhou. Such stark contrast in distribution strongly suggested that *chuji*, unlike the remaining three terms, was not restricted to a particular

26. *Mao shi zhengyi* 毛詩正義 (Beijing: Beijing daxue, 2000), 13.935a–b ("Xiao ming" 小明).

27. Wang Yinzhi, *Jingyi shuwen* 經義述聞, *Xuxiu siku quanshu* 續修四庫全書, vol. 175 (Shanghai: Shanghai guji, 2002), 31.325a.

28. Liu Chaoyang 劉朝陽, "Zhouchu lifa kao" 周初曆法考, in *Liu Chaoyang Zhongguo tianwenxueshi lunwen xuan* 劉朝陽中國天文學史論文選 (Zhengzhou: Daxiang, 1999), 191–301; Huang Shengzhang 黃盛璋, "Shi chuji" 釋初吉, *Lishi yanjiu* 歷史研究 1958.4, 71–86; Pankenier, "Reflections of the Lunar Aspect."

29. Wang Guowei, "Shengba siba kao" 生霸死霸考, in *Guantang jilin* 觀堂集林, *Wang Guowei quanji*, vol. 8, 1.1–6.

30. Shinjō Shinzō, *Dongyang tianwenxueshi yanjiu* 東洋天文學史研究, trans. Shen Xuan 沈璿 (Shanghai: Zhonghua xueyi, 1933), 47–49.

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period of the lunar month, and hence was not related, semantically or functionally, to the lunar phase.[31]

The first year and third year Shi Dui *gui* 師兌簋 (nos. 4 & 13) can be confidently placed in the same reign based on their inscriptions, each of which includes a complete date using the term *chuji*. Ma Chengyuan calculated the relative lunar phase span between these two dates to be fourteen days (inclusive),[32] which is the minimal range of *chuji* if it describes the lunar phase. However, interpretations of *chuji* linking it to the lunar phase, semantically or functionally, only permit a maximum span of ten days, and are thus all rejected. Therefore, *chuji* is unrelated to the lunar phase and shall be omitted from subsequent analysis.

JISHENGBA, *JIWANG*, AND *JISIBA*: FOUR HYPOTHESES

Starting with Liu Xin, pre-modern scholars invariably proposed fixed-point interpretations for *jishengba*, *jiwang*, and *jisiba*, based on analysis of received texts. Wang Guowei was the first to systematically analyze bronze inscription dates, and he pioneered segmental interpretations for the specialized terms. He proposed that *jishengba* started the day after the first quarter and ended the day before the full moon, *jiwang* started on the full moon—or *wang* 望—and ended on the last quarter, and *jisiba* started the day after the last quarter and ended on the day before *shuo*—or *hui* 晦.[33] Shinjō modified Wang Guowei's interpretations so that *jishengba* began on the day after the first quarter and ended on *wang*, *jiwang* began the day after *wang* and ended on the last quarter, and *jisiba* began the day after the last quarter and ended the day before *fei*.[34]

Although Wang Guowei's interpretations of the specialized terms became quite influential, alternatives have been proposed. Chen Jiujin proposed that *jishengba* starts on *fei* and ends on *wang*; *jiwang* is the day after *wang*; and *jisiba* starts the day after *jiwang* and ends the day before *fei*.[35] Wang Shengli 王勝利 proposed that *jishengba* starts the day after *fei* and ends on *wang*; *jiwang* starts the day after *wang* and ends on the last day the waning crescent remains visible (*hui* or the day before *hui*); and *jisiba* starts on the first invisibility of the waning crescent (*hui* or

31. Liu Yu, "Jinwen 'chuji' bianxi" 金文"初吉"辨析, *Wenwu* 1982.11, 76–84.
32. Ma Chengyuan, "Xi-Zhou jinwen he Zhouli de yanjiu."
33. Wang Guowei, "Shengba siba kao."
34. Shinjō, *Dongyang tianwenxueshi yanjiu*, trans. Shen Xuan, 47–49.
35. Chen Jiujin, "Xi-Zhou yueming riming kao" 西周月名日名考, *Ziran kexueshi yanjiu* 自然科學史研究 4.2 (1985), 120–30; Pankenier put forth a similar proposal in "Reflections of the Lunar Aspect."

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Table 1. Summary of Lunar Phase Hypotheses

Hypothesis	*Jishengba*		*Jiwang*		*Jisiba*	
	Start	End	Start	End	Start	End
A	*Fei*	*Wang*	*Wang* + 1	Last quarter (qtr.)	Last qtr. + 1	*Fei* – 1
B	*Fei*	*Wang*	*Wang* + 1 (fixed point)		*Wang* + 2	*Fei* – 1
C	*Fei* + 1	*Wang*	*Wang* + 1	*Hui* / *Hui* – 1	*Hui* / *Shuo*	*Fei*
D	*Fei*	*Wang* – 1	*Wang*	Last qtr. + 2 / 3	Last qtr. + 3 / 4	*Fei* – 1

shuo) and ends on *fei*.[36] Wang Zhankui proposed that *jishengba* starts on *fei* and ends the day before *wang*; *jiwang* starts on *wang* and ends one or two days after the last quarter; and *jisiba* starts the day after *jiwang* and ends the day before *fei*.[37] None of the alternative proposals treat *chuji* as a lunar phase.

The forty-second year and forty-third year Lai *ding* belong to the same reign. Both bear inscription dates using the term *jishengba*. Zhang Peiyu calculated their relative lunar phase difference to be eight days (exclusive).[38] The relative lunar phase span of *jishengba* is thus nine days (inclusive), which exceeds the maximum range of the interpretations proposed by Wang Guowei or Shinjō (7–8 days). The relative lunar phase spans for *jiwang* and *jisiba* could not be analyzed due to the lack of appropriate material. Therefore, although Wang Guowei's and Shinjō's interpretations of *chuji* and *jishengba* have been rejected by archaeological evidence, their interpretations for *jiwang* and *jisiba* have not.

To summarize, four hypotheses regarding the interpretations of *jishengba*, *jiwang*, and *jisiba* can be formulated (Table 1). They will each be tested using the simplified criterion described in the previous section.

Hypothesis Testing Using Empirical Evidence

MATERIAL

Of the complete inscription dates from late Western Zhou with regnal years greater than twenty, eight use the term *jishengba*, *jiwang*, or *jisiba*. These include the inscription dates of Yi *gui* 伊簋, Huan *pan* 寰盤, Jin Hou Su *zhong* 晉侯䵼鐘, Bo Kuifu *xu* 伯寬父盨, as well as the forty-second year and forty-third year Lai *ding* (nos. 63, 66, 71a–c, 72, 75, 76; the

36. Wang Shengli, "Xi-Zhou lifa de yueshou, nianshou he jiri ciyu xintan" 西周曆法的月首、年首和記日詞語新探, *Ziran kexueshi yanjiu* 9.1 (1990), 38–46.
37. Wang Zhankui, "Xi-Zhou liewang jinian nice."
38. Li Xueqin, "Meixian Yangjiacun xinchu qingtongqi yanjiu."

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fourth inscription date of Jin Hou Su *zhong* [no. 71d] uses the term *chuji* and is omitted from this initial analysis).

The original term used by the inscription date of Bo Kuifu *xu* is *jisi* 既死, which is not among the four standard terms. Liu Qiyi reads it as *jiwang*, whereas Nivison reads it as *jisiba*.[39] Liu Qiyi's reading changes the inscribed character *si* to *wang*, whereas Nivison's reading preserves the original inscription by assuming that the character *ba* was erroneously omitted. This study adopts Nivison's reading to avoid altering the inscription.

The second and third date of Jin Hou Su *zhong* are both in the second month, but the *ganzhi* of the third date (*renyin* 壬寅 [39]) precedes that of the second date (*guimao* 癸卯 [40]). This has led many to believe that the dates contain errors.[40] However, Feng Shi 馮時 argued that the two dates are in different years, in which case there is no error.[41] To avoid altering the evidence, this study follows Feng Shi's reasoning, and places the third date in the year after the second date. All the inscription dates of Jin Hou Su *zhong* must have common solutions.

The inscriptions of both Lai *ding* mention Scribe Yu 史㝬, who also appears in the inscription of Huan *pan*. The inscription of Huan *pan* records a regnal year of twenty-eight, and thus must be in the same reign as Lai *ding*. Therefore, all three vessels must be in King Xuan's reign,[42] meaning that the dates of Lai *ding* and Huan *pan* must have common solutions, which are candidates for King Xuan's *yuan*.

RESULTS

The relative compatibility of the eight selected dates was analyzed according to each of the four hypotheses, for each year between 900 and 800 B.C.E. (inclusive). The first visibility of the lunar crescent is usually one or two days after *shuo*, whereas the first invisibility of the crescent is usually on *hui* or *shuo*. Neither can be predicted with certainty. To

39. Liu Qiyi, "Bo Kuifu xuming yu Liwang zaiwei nianshu" 伯寬父盨銘與厲王在位年數, *Wenwu* 1979.11, 16–20; David S. Nivison, "Two *Yuan* and Four Quarters," in *The Nivison Annals*, ed. Adam C. Schwartz (Boston: De Gruyter Mouton, 2018), 220–38.

40. Ma Chengyuan, "Jinhou Su bianzhong" 晉侯穌編鐘, *Shanghai bowuguan jikan* 7 (1996), 1–17; Wang Shimin 王世民, Li Xueqin, Chen Jiujin, Zhang Wenyu 張聞玉, Zhang Peiyu, Gao Zhixi 高至喜, and Qiu Xigui 裘錫圭, "Jinhou Su zhong bitan" 晉侯蘇鍾筆談, *Wenwu* 1997.3, 54–66; Jaehoon Shim, "The 'Jinhou Su *Bianzhong*' Inscription and Its Significance," *Early China* 22 (1997), 43–75; David S. Nivison and Edward L. Shaughnessy, "The Jin Hou Su Bells Inscription and Its Implications for the Chronology of Early China," *Early China* 25 (2000), 29–48.

41. Feng Shi, "Jinhou Su zhong yu Xi-Zhou lifa" 晉侯穌鐘與西周曆法, *Kaogu xuebao* 考古學報 127 (1997), 407–42.

42. Li Xueqin, "Meixian Yangjiacun xinchu qingtongqi yanjiu."

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simplify calculations, the waxing crescent is assumed to be visible the day after *shuo*, and the waning crescent is assumed to be invisible on *hui*.

All four hypotheses assume that the Western Zhou calendar month begins on *fei* or the day after *fei*, which is one to three days after *shuo*—the beginning of the month in the reference calendar. This discrepancy is accounted for in the analysis results.

According to hypothesis A, the dates of Huan *pan*, Lai *ding*, and Bo Kuifu *xu* can be accommodated in the same reign. The dates of Jin Hou Su *zhong* can be accommodated in a separate reign. However, the inscription date of Yi *gui* cannot fit in either reign, meaning that under hypothesis A, at least three reigns are required to accommodate all the dates (Table S2). Hypothesis A is therefore rejected.

According to hypothesis B, a minimum of three reigns is required to accommodate all the selected dates: one for Huan *pan*, Lai *ding*, and Bo Kuifu *xu*, one for Jin Hou Su *zhong*, and a third for Yi *gui* (Table S3). Hypothesis B is thus rejected as well.

Interestingly, according to hypothesis C and D, Jin Hou Su *zhong* can be placed into the same reign as Huan *pan* and Lai *ding*. Yi *gui* and Bo Kuifu *xu* can then be placed together in a separate reign (Tables S4 and S5). The selected dates can thus be accommodated by two reigns. Therefore, neither hypothesis can be rejected.

Hypothesis C provides a clear and consistent interpretation of the character *ba* 霸 as the illuminated portion of the moon, and suggests a practical procedure for subdividing the calendar month based on direct observation of the most visible lunar phase changes: On the first or second day after conjunction, the waxing crescent is observed shortly after sunset. The next day marks the start of *jishengba* ("the bright portion of the moon has been born"), which Wang Shengli believed also marked the start of a new calendar month.[43] Around the middle of the month, a full moon is observed after sunset. The next day marks the start of *jiwang* ("after lunar opposition"). Towards the end of the month, the waning crescent becomes progressively thinner as it rises after midnight, until one morning the crescent is no longer observed before sunrise. The day that begins at sunrise is the first day of *jisiba* ("the bright portion of the moon has died"). This system implies that the Western Zhou calendar day began at sunrise.

In contrast, hypothesis D cannot provide a clear interpretation of *ba*. Therefore, hypothesis C is accepted as the proper interpretation of *jishengba*, *jiwang*, and *jisiba*.

43. Wang Shengli, "Xi-Zhou lifa de yueshou, nianshou he jiri ciyu xintan."

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Chronological Reconstruction

The Dates of Late Western and Early Eastern Zhou

KING XUAN

There are a total of ten common solutions for the inscription dates of Huan *pan*, Lai *ding*, and Jin Hou Su *zhong* between 900 and 800 B.C.E. (inclusive). These are candidates for King Xuan's *yuan*. Considering the rough time period of King Xuan, the most likely candidates are 841, 836, or 831 B.C.E. (the next available options, 867 and 810 B.C.E., are either too early or too late; see Table S4).

According to hypothesis C, determination of *jishengba* depends on observing the waxing crescent. The previous analysis permitted a lunar phase error of ±1 day for *jishengba*. However, a lunar phase error of −1 day for *jishengba* means that the waxing crescent was observed on the day of conjunction, when it should have been invisible—a highly unlikely scenario. Therefore, search results for *jishengba* dates with a lunar phase error of −1 are excluded, rejecting 831 B.C.E. as King Xuan's *yuan*.

Under hypothesis C, the range of *jisiba* is the most restrictive, lasting only three days from *hui* to the day after *shuo*, and up to five days allowing for lunar phase errors. Dates using *jisiba* are thus the most useful for restricting possible solutions. Xi Jia 兮甲 盤 *pan* (no. 28) is generally accepted as a vessel from King Xuan's reign, and its inscription date uses the term *jisiba*. If King Xuan's reign accommodates the inscription date of Xi Jia *pan*, then King Xuan's *yuan* can only be 836 B.C.E. Fixing King Xuan's *yuan* at 836 B.C.E. then places Jin Hou Su *zhong* in 804–803 B.C.E., which is consistent with radiocarbon dating results.[44]

KING YOU

The inscription date of Song *ding* 頌鼎 (no. 19) also uses the term *jisiba*. Song *ding* cannot be placed in King Xuan's reign, nor can it be placed in King Li's reign (the reign containing Yi *gui* and Bo Kuifu *xu*). Notably, Song *ding* can be placed in a reign that begins in 790 B.C.E., which is exactly forty-six years after King Xuan's *yuan* (836 B.C.E.), agreeing with the traditional account that King Xuan ruled for forty-six years. Therefore, Song *ding* is placed in King You's reign, which takes 790 B.C.E. as *yuan*.

44. Qiu Shihua 仇士華 and Zhang Changshou 張長壽, "Jinhou mudi M8 de tanshisi niandai ceding he Jinhou Su zhong" 晉侯墓地M8的碳十四年代測定和晉侯穌鍾, *Kaogu* 1999.5, 90–92.

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KING PING AND KING HUI OF XIE 攜惠王

The dates of Kings Xuan and You derived from bronze inscriptions deviate significantly from the chronology in *Shi ji*. It thus becomes appropriate to consider chapter two of *Xinian*, which records an alternative narrative of the transition from Western to Eastern Zhou, excerpted below:

> King You of Zhou took a wife from Western Shen 西申, and she gave birth to King Ping. The king also took a woman from the people of Bao 褒, this was Lady Bao Si 褒姒, and she gave birth to Bopan 伯盤. Lady Bao Si was favored by the king. His Majesty loved Bopan, and thus forced King Ping into exile: King Ping fled to Western Shen. King You raised an army and laid siege to King Ping at Western Shen, but the people of Shen did not yield. The people of Zeng 繒 then joined with the Western Rong 西戎, in order to attack King You; King You and Bopan were killed and Zhou was destroyed. The lords of the various states and the elders then established King You's younger brother, Yu Chen 余臣, in Guo 虢, and he became King Hui of Xie. He was established for twenty-one years, after which Chou 仇, Marquis Wen of Jin 晉文侯, killed King Hui in Guo. In *Zhou wuwang jiunian* 周亡王九年, the lords of the various states began not to pay court to Zhou. Marquis Wen of Jin met King Ping at Shao'e 少鄂 and had him take the throne in the capital (Jingshi 京師). In the third year, he moved the capital east, taking up residence in Chengzhou 成周. The people of Jin then began to open up land around the capital. Lord Wu of Zheng 鄭武公 was also the leader of the lords in the eastern regions.[45]

Unlike the narrative in *Shi ji*, King Ping did not become king immediately after King You's death, but rather took the throne in *Zhou wuwang jiunian*. The interpretation of this phrase is thus critical to establishing the absolute dates of King Ping. Wang Hongliang 王紅亮 reads this phrase as "the ninth year of King Wang of Zhou," and identified King Wang of Zhou (*Zhou wangwang* 周亡王) with King You.[46] However, it is unclear from the text whether *Zhou wangwang* is the title of a king. Even if there was a King Wang of Zhou, there's no evidence from the text that identifies him with King You. Therefore, Wang Hongliang's interpretation is rejected.

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45. Li Xueqin, ed., *Qinghua daxue cang Zhanguo zhujian (er)*, 138. Translation based on Olivia Milburn, "The *Xinian*: An Ancient Historical Text from the Qinghua University Collection of Bamboo Books," *Early China* 39 (2016), 53–109, with slight modifications.

46. Wang Hongliang, "Qinghuajian '*Xinian*' zhong Zhou Pingwang dongqian de xiangguan niandai kao" 清華簡《繫年》中周平王東遷的相關年代考, *Shixueshi yuekan* 史學史月刊 148 (2012), 101–9.

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Wei Dong 魏棟 read the phrase as "Zhou fell, and in the ninth year of the king" (周亡, 王九年), and argued that, because previous unqualified mentions of the king (*wang* 王) in chapter two all referred to King You, "the ninth year of the king" (*wang jiunian* 王九年) was King You's ninth year.[47] However, the king last mentioned in the preceding text is King Hui of Xie, which would suggest that *wang jiunian* is King Hui's ninth year. Moreover, the text already stated that "Zhou was destroyed" (*Zhou naiwang* 周乃亡) after the death of King You and Bopan. It would thus be self-contradictory to restate that "Zhou fell" (*Zhou wang* 周亡) after Marquis Wen of Jin killed King Hui in Guo. Therefore, Wei Dong's interpretation is also rejected.

The only remaining option for interpreting the phrase *Zhou wuwang jiunian* is to read it as "the ninth year that Zhou was without a king." However, there are disagreements over when the year count starts for "Zhou without a king." One view argues that the count starts after the death of King Hui of Xie, assuming that the events in chapter two of *Xinian* are in strict chronological order.[48] Under this view, King Ping's reign starts after King Hui of Xie is killed. However, this contradicts the *Bamboo Annals*, which states that "two kings were simultaneously established" (二王並立) after King You's death.[49]

The alternative view, voiced by the editors of *Xinian*, argues that the count starts from King You's demise.[50] Under this view, "Zhou without a king" (周亡王) is interpreted as "the Zhou capital was without a king." The narrative is understood to bifurcate after King You's death: one branch recounts the events of King Hui of Xie, whereas the other follows the events of King Ping.[51] Therefore, the events in chapter two of *Xinian* need not be in strict chronological order, allowing the reigns of King Hui of Xie and King Ping to partially overlap in time—i.e. King

47. Wei Dong, "Qinghuajian '*Xinian*' 'Zhou wang wang jiunian' ji xiangguan wenti xintan" 清華簡《繫年》"周亡王九年"及相關問題新探, http://fdgwz.org.cn/Web/Show/1895, accessed on June 15, 2022.

48. Liu Guozhong 劉國忠, "Cong Qinghuajian '*Xinian*' kan Zhou Pingwang dongqian de xiangguan shishi" 從清華簡《繫年》看周平王東遷的相關史實, in Chen Zhi 陳致, ed., *Jianbo, jingdian, gushi* 簡帛　經典　古史 (Shanghai: Shanghai guji, 2013), 173–79; Chen Minzhen and Yuri Pines, "Where is King Ping? The History and Historiography of the Zhou Dynasty's Eastward Relocation," *Asia Major* 31.1 (2018), 1–27.

49. Fang Shiming 方詩銘 and Wang Xiuling 王修齡, *Guben Zhushu jinian jizheng* 古本竹書紀年輯證 (Shanghai: Shanghai guji, 2005), 63–64.

50. Li Xueqin, ed., *Qinghua daxue cang Zhanguo zhujian (er)*, 139n9.

51. Wang Zhankui, "Qinghua jian '*Xinian*' suizha—Wenhou Chou sha Xiewang yu Pingwang, Xiewang jinian" 清華簡《繫年》隨札——文侯仇殺攜王與平王、攜王紀年, *Gudai wenming* 古代文明 10 (2016), 205–14.

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Hui of Xie and King Ping were "simultaneously established," consistent with the *Bamboo Annals*.

Therefore, considering both *Xinian* and the *Bamboo Annals*, this study counts the nine years that Zhou was without a king starting from King You's demise. King You's reign began in 790 B.C.E. and lasted for eleven years, ending in 780 B.C.E. By inclusive counting, the ninth year that Zhou was without a king would be 772 B.C.E. According to *Xinian*, King Ping was established by Marquis Wen of Jin that year. If King Ping took 772 B.C.E. as *yuan*, then his third year would be 770 B.C.E. (Table 2). According to *Xinian*, that was the year he moved east to Chengzhou.

By this analysis, although the relative chronology of King Ping's eastward move differs significantly between *Shi ji* and *Xinian*, the two texts agree on the absolute date of this event. This phenomenon suggests a simple explanation for the discrepancies in the relative chronology: Sima Qian likely knew the absolute date of King Ping's eastward move, as well as the reign lengths of Kings You and Xuan. However, he was apparently unaware of King Hui of Xie and the seven-year gap between King You's final year and King Ping's *yuan*. Therefore, Sima Qian placed King Ping's eastward move in King Ping's *yuan* and assumed that year to immediately follow King You's last year. This also explains the discrepancy between *Shi ji* and the inscription dates of Lai *ding*.

Previous analyses generally assumed that Sima Qian's dates for King You were accurate when attempting to adjust King Ping's dates to reconcile *Xinian* with *Shi ji*. This implies that the more recent dates of King Ping are less accurate than the more distant dates of King You, which is counterintuitive. This study shows that King Ping's dates in *Shi ji* are offset by only two years, whereas the dates for King You (and Xuan) are offset by nine years. The more recent dates are more accurate than the more distant dates, consistent with common sense.

In conclusion, King Ping reigned from 772 to 720 B.C.E., whereas King Hui of Xie ruled from 779 to 759 B.C.E.

KING LI AND THE GONGHE REGENCY

Yi *gui* and Bo Kuifu *xu* belong to King Li's reign. The inscription of Bo Kuifu *xu* records a regnal year of 33. Since King Xuan's *yuan* is 836 B.C.E., King Li's *yuan* must be no later than 869 B.C.E. If the Gonghe regency established a separate year count, then its first year would be 850 B.C.E. (fourteen years before King Xuan's *yuan*), and King Li's *yuan* must be no later than 883 B.C.E.

If King Li's *yuan* is before 883 B.C.E., it can be no later than 891 B.C.E. (Table S4). In this scenario, King Li would have ruled for at least forty-one years before the start of the Gonghe regency in 850 B.C.E. The

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Table 2. Alternative Chronologies of Late Western and Early Eastern Zhou

	Shi ji	This Study		
B.C.E.	Zhou Kings	Zhou Kings	Xie King	Zhou without king
790	Xuan 38	You *yuan*		
789	39	2		
788	40	3		
787	41	4		
786	42	5		
785	43	6		
784	44	7		
783	45	8		
782	46	9		
781	You *yuan*	10		
780	2	11		1
779	3		Hui *yuan*	2
778	4		2	3
777	5		3	4
776	6		4	5
775	7		5	6
774	8		6	7
773	9		7	8
772	10	Ping *yuan*	8	9
771	11	2	9	
770	Ping *yuan*	3	10	
769	2	4	11	
768	3	5	12	
767	4	6	13	
766	5	7	14	
765	6	8	15	
764	7	9	16	
763	8	10	17	
762	9	11	18	
761	10	12	19	
760	11	13	20	
759	12	14	21	

justification for the Gonghe regency was that King Xuan was too young when King Li fled the capital, an unlikely scenario if King Li had already reigned for over four decades by then. Therefore, the Gonghe regency did not establish a separate year count, and King Li's *yuan* can only be 870, 875, or 880 B.C.E. (Table S4).

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If the Gonghe regency is included in King Xuan's reign, it would constitute its first fourteen years. Xi Jia *pan* has been placed in King Xuan's fifth year. Its inscription states that "Xi Jia followed the king to behead, capture, and interrogate (enemy soldiers)" (兮甲從王折首執訊). The inscription implies that King Xuan personally led an army into battle, which would be unlikely if the king was so young that he required a regent. Therefore, the Gonghe regency should be included in King Li's reign, constituting King Li's final fourteen regnal years, from 850 to 837 B.C.E.

According to "Zhou benji" 周本紀, King Li was driven out of the capital in his thirty-seventh year. In "Wei Kangshu shijia" 衛康叔世家, this event occurred in Marquis Li's 釐侯 thirteenth year. "Wei Kangshu shijia" also states that Marquis Li's father, Marquis Qing 頃侯, bribed King Li's father, King Yi 夷王, to promote Wei's nobility rank from count (*bo* 伯) to marquis (*hou* 侯). However, Marquis Qing ruled for only twelve years,[52] which implies that King Li ruled for no more than twenty-four years before fleeing the capital, contradicting "Zhou benji." King Li's dates in "Wei Kangshu shijia" likely reflect primary material available to Sima Qian that was related to the state of Wei, making this chapter more reliable than "Zhou benji," whose dates are known to be inaccurate. If the Gonghe regency started in 850 B.C.E. and King Li fled the capital no later than his twenty-fourth year, then King Li's *yuan* can be no earlier than 874 B.C.E. Therefore, King Li's *yuan* must be 870 B.C.E.

VALIDATION

Thus far, a total of ten inscription dates have been used, with the help of *Xinian*, the *Bamboo Annals*, and *Shi ji*, to derive the absolute dates of Kings Li, Xuan, You, Ping, and Hui (of Xie). The remaining complete inscription dates from late Western Zhou can be used to validate the results. Due to complications related to intercalation, dates in the thirteenth month will be excluded from this process and analyzed separately. Omitting dates using the term *chuji*, there remain eleven inscription dates from the late period: those of Shi Xun *gui* 師訇簋, Ni *zhong* 逆鍾, Bo Lüfu *xu* 伯呂父盨, Shi X *gui* 師艱簋, Shi You *pan* 師酉盤, fifth year Shi Shi *gui* 師旗簋, Da *gui* 大簋, fifteenth year Da *ding* 大鼎, Bo Ke *hu* 伯克壺, Ci *ding* 此鼎, and Ma *ding* 趞鼎 (nos. 2, 3, 8, 9, 22, 29, 43, 47, 49, 52, 55).

All dates can be accommodated by at least one of the reigns of Kings Li, Xuan, and You (Tables 3 and S6). Ni *zhong* and Shi You *pan* (nos. 3, 22) can be placed in the reign of King Xuan or You. Da *gui*, Bo Ke *hu*, Ci *ding*,

52. *Shi ji*, 4.180–81, 37.1925.

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Table 3. Summarized Chronology of Late Western Zhou

B.C.E.	King	Yr.	Vessel / Date	No.	Used for	Note
	Yi	1	Shi Xun *gui*	**2**		Date undetermined
870	Li	1	Bo Lüfu *xu*	**8**	Validation	
			Shi X *gui*	**9**	Validation	
866		5	5th yr. Shi Shi *gui*	**29**	Validation	
856		15	15th yr. Da *ding*	**47**	Validation	
844		27	Yi *gui*	**63**	**Calculation**	
838		33	Bo Kuifu *xu*	**72**	**Calculation**	
837		34				Final year of reign
836	Xuan	1				
832		5	Xi Jia *pan*	**28**	**Calculation**	
825		12	Da *gui*	**43**	Validation	
821		16	Bo Ke *hu*	**49**	Validation	
820		17	Ci *ding*	**52**	Validation	
818		19	Ma *ding*	**55**	Validation	
809		28	Huan *pan*	**66**	**Calculation**	
804		33	Jin Hou Su *zhong*	**71a**	**Calculation**	
			Jin Hou Su *zhong*	**71b**	**Calculation**	
803		34	Jin Hou Su *zhong*	**71c**	**Calculation**	
795		42	42nd yr. Lai *ding*	**75**	**Calculation**	
794		43	43rd yr. Lai *ding*	**76**	**Calculation**	
791		46				Final year of reign
790	You	1	Ni *zhong*	**3**	Validation	Non-unique solution
788		3	Song *ding*	**19**	**Calculation**	
780		11				Final year of reign

and Ma *ding* (nos. 43, 49, 52, 55) fit in King Xuan's reign, whereas the fifth year Shi Shi *gui* and fifteenth year Da *ding* (nos. 29, 47) fit in King Li's reign.

The inscription dates of Shi Xun *gui*, Bo Lüfu *xu*, and Shi X *gui* (nos. 2, 8, 9) are all in the first year and are compatible only with King Li's reign. However, the inscription date of Shi Xun *gui* requires that King Li's *yuan* begin in the month of *zi* (mo. error = 0), whereas the other two dates require King Li's *yuan* begin in the month before or after *zi* (mo. error = ±1; see Table S6). Therefore, these three vessels cannot all fit in King Li's *yuan*.

The inscription of Shi Xun *gui* quotes the king addressing the donor: "Woe! Shi Xun! Presently the angry terrors and disasters of Heaven have descended upon us. The virtue of the monarch is inadequate to rule. Thus, I did not succeed the deceased king. Previously, you, with

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a pure heart and anxiously concerned about the Zhou state, peacefully established my humble self" (師訇, 哀哉! 今日天疾威降喪, 首德不克妻, 故亡承于先王. 鄉汝彶純卹周邦, 綏立余小子). Although there are alternative interpretations,[53] this study adopts Peng Yushang's 彭裕商 interpretation of the phrase "*wu chengyu xianwang*" 亡承于先王 as "did not succeed the deceased king."[54] He Jingcheng 何景成 believes this phrase describes the succession of King Yi,[55] who did not immediately succeed his father King Yih 懿王 but only became king after the death of King Xiao 孝王, with help from Zhou's vassals.[56] Presumably, Shi Xun was one of the vassals who helped establish King Yi. Shi Xun *gui* is thus assigned to King Yi's reign, enabling Bo Lüfu *xu* and Shi X *gui* to be placed in King Li's *yuan* (Table 3).

All eleven dates have now been accounted for, validating the derived dates of Kings Li, Xuan, and You. However, since Shi You is associated with many vessels from the middle stage of Western Zhou, the placement of Shi You *pan* shall be reconsidered in the following section.

The Dates of Middle Western Zhou

The middle stage of Western Zhou includes the reigns of Kings Mu 穆王, Gong 恭王, Yih, Xiao, Yi, and sometimes the latter half of King Zhao's 昭王 reign. The lengths of these reigns are generally unknown. *Shi ji* states that King Mu ruled for fifty-five years and lived for over 100 years.[57] However, the *Bamboo Annals* contradicts this account, stating instead that "from Zhou's receipt of the Mandate to King Mu there were 100 years, and King Mu's lifespan was not 100 years" (自周受命至穆王百年, 非穆王壽百歲也).[58] Therefore, the length of King Mu's reign is treated as unknown.

INITIAL ESTIMATES

The inscription of the fifteenth year Que Cao *ding* 趞曹鼎 (no. 48) states that "in the fifth month of the fifteenth year, *jishengba*, on the day *renwu* (19), King Gong was in the new palace of Zhou" (唯十又五年五月既生霸壬午, 龔王在周新宮). Therefore, King Gong ruled for at least fifteen years. In the Jun *gui* 畯簋 (no. 37) inscription, the king mentions his

53. Zhou Baohong 周寶宏, "Shixun gui mingwen huishi" 師詢簋銘文匯釋, *Zhongguo wenzi yanjiu* 中國文字研究 6 (2005), 26–31.

54. Peng Yushang, *Xi-Zhou qingtongqi zonghe yanjiu* 西周青銅器綜合研究 (Chengdu: Bashu, 2003), 17.

55. He Jingcheng, "Lun Shixun gui de shishi he niandai" 論師詢簋的史實和年代, *Nanfang wenwu* 南方文物 2008.4, 104–7, 114.

56. *Shi ji*, 4.179.

57. *Shi ji*, 4.172–78.

58. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 47.

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"exalted and illustrious father King Gong" (丕顯考龔王), thus identifying himself as King Yih, King Gong's successor. The inscription date of Jun *gui* is in the tenth year, meaning that King Yih ruled for at least ten years. The *Bamboo Annals* implies that Kings Yi, Mu, and Zhao ruled for a minimum of seven, thirty-seven, and nineteen years, respectively.[59] King Xiao is assumed to have reigned for at least one year.

King Li's *yuan* is 870 B.C.E. Since King Yi's reign lasted at least seven years and must accommodate the inscription date of Shi Xun *gui*, King Yi's *yuan* must be no later than 879 B.C.E. (see Table S8). Consequently, the lower estimates of the *yuan* of Kings Xiao, Yih, Gong, Mu, and Zhao are 880, 890, 905, 942, and 961 B.C.E., respectively.

REFINEMENT

Of the inscription dates listed in Appendix A, four are found on vessels belonging to Qiu Wei 裘衛: Qiu Wei *he* 裘衛盉, fifth year Wei *ding* 衛鼎, ninth year Wei *ding*, and twenty-seventh year Wei *gui* 衛簋 (nos. 14, 26, 36, 64). The overall timespan of these vessels must be reasonable.

The inscription of the fifth year Wei *ding* mentions King Gong. Therefore, this vessel cannot precede King Gong's reign. The inscription date of the twenty-seventh year Wei *gui* is in the twenty-seventh year, and the only king in middle Western Zhou known to have a twenty-seventh year is King Mu. Therefore, the most reasonable placement of this vessel is in King Mu's reign. Taken together, Qiu Wei's four vessels should span the reigns of Kings Mu and Gong,[60] and may possibly extend to King Yih's reign.

Shi Hu *gui* 師虎簋 and Hu *gui* 虎簋 (nos. 6, 67) are also thought to belong to the same person. The inscription date of Hu *gui* is in the thirtieth year, placing it most reasonably in King Mu's reign.[61] The inscription date of Shi Hu *gui* is in the first year (*yuan*). Considering its chronological distance from Hu *gui*, Shi Hu *gui* should be placed in the reign of King Mu, Gong, or Yih.[62]

The compatibility of the inscription dates of the Qiu Wei vessels, Hu vessels, and fifteenth year Que Cao *ding* were analyzed for the years between 990 and 890 B.C.E. (inclusive, the inscription dates of the fifth

59. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 46–57.

60. Pang Huaiqing 龐懷清, Zhenfeng 鎮烽, Zhongru 忠如, and Zhiru 志儒, "Shaanxi sheng Qishan xian Dongjia cun Xi-Zhou qingtongqi jiaoxue fajue jianbao" 陝西省岐山縣董家村西周青銅器窖穴發掘簡報, *Wenwu* 1976.5, 26–44, 96–98; Shaughnessy, *Sources of Western Zhou History*, 248.

61. Wang Hanzhang 王翰章, Chen Lianghe 陳良和, and Li Baolin 李保林, "Hugui gaiming jianshi" 虎簋蓋銘簡釋, *Kaogu yu wenwu* 1997.3, 78–80, 75.

62. In theory, Shi Hu *gui* may also be placed in King Zhao's reign. However, King Zhao's early years are generally not considered part of the middle stage of Western Zhou.

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year Wei *ding* and Hu *gui* use the term *chuji* and were thus omitted). The inscription date of twenty-seventh year Wei *gui* is highly incompatible with that of Qiu Wei *he*, but highly compatible with that of ninth year Wei *ding*. On the other hand, ninth year Wei *ding* and Qiu Wei *he* share only four common solutions over 101 years, and in each case one or both dates contain a lunar phase error, displaying poor compatibility (Table S7). Therefore, ninth year Wei *ding* and twenty-seventh year Wei *gui* were both placed in King Mu's reign. Qiu Wei *he* was then placed in King Gong's reign, along with fifth year Wei *ding*, to minimize the total timespan of the Qiu Wei vessels. If King Gong's reign must accommodate both Qiu Wei *he* and fifteenth year Que Cao *ding*, then it cannot accommodate Shi Hu *gui*, which is placed in King Yih's reign instead.

King Mu's *yuan* is assumed to be no earlier than 970 B.C.E. Between 942 and 970 B.C.E., the inscription dates of ninth year Wei *ding* and twenty-seventh year Wei *gui* have five common solutions. If solutions with lunar phase errors are rejected, then possible candidates for King Mu's *yuan* are 947, 952, and 957 B.C.E.

King Mu reigned for at least thirty-seven years. Therefore, King Gong's *yuan* can be no earlier than 920 B.C.E. Between 905 and 920 B.C.E., the dates of Qiu Wei *he* and fifteenth year Que Cao *ding* have three common solutions: 906, 911, and 917 B.C.E. These are candidates for King Gong's *yuan*.

King Gong ruled for at least fifteen years. Therefore, King Yih's *yuan* can be no earlier than 902 B.C.E., and it must also accommodate the inscription date of Shi Hu *gui*. Possible candidates for King Yih's *yuan* thus include 899, 898, 894, 893, and 892 B.C.E. King Yih ruled for at least ten years, therefore King Xiao's *yuan* can be no earlier than 889 B.C.E.

Both dates of Hu *ding* 舀鼎 (no. 7a–b) are compatible with the inscription date of Shi Hu *gui* (Table S8). However, the Shi Hu *gui* inscription states that the king was in the great hall of *shela* (王在社宲, 格于大室) on *jiaxu* 甲戌 (11), and Jing Bo 井伯 was the right-hand convoy who ushers Shi Hu into the king's presence. In contrast, in the Hu *ding* inscription, the king was in the great hall of King Mu's temple (王在周穆王大室) on *yihai* 乙亥 (12), and Jing Shu 井叔 was Hu's right-hand convoy. The two vessels are thus most reasonably placed in separate reigns,[63] excluding Hu *ding* from King Yih's reign. The inscription dates of Hu *ding* are incompatible with King Gong's putative *yuan* of 906, 911, or 917 B.C.E., nor are they compatible with the inscription date of Shi Xun *gui* (Table

63. Chen Mengjia 陳夢家, *Xi-Zhou tongqi duandai* 西周銅器斷代 (Beijing: Zhonghua, 2004), 197–99. However, others have placed Hu *ding* in the same reign as Shi Hu *gui*, see Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 31.

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S8), thus excluding Hu *ding* from the reign of King Gong or Yi. King Mu's temple is mentioned in the Hu *ding* inscription, excluding the vessel from King Mu's reign as well. Therefore, Hu *ding* is placed in King Xiao's reign.

In the inscription of Shi You *gui* 師酉簋 (no. 77), the king calls out Scribe Qiang 史牆 to command Shi You in writing. In the inscription of Shi You *pan* (no. 22), the king calls out Qiang to perform the same function. Zhang Changshou 張長壽 noted a high degree of similarity between the inscriptions of the two vessels, and identified Qiang in the Shi You *pan* inscription with Scribe Qiang in the Shi You *gui* inscription.[64] Scribe Qiang is the donor of Scribe Qiang *pan* 史牆盤 (no. 118). Based on the inscription of this vessel, Scribe Qiang's lifetime spanned the reigns of Kings Gong and Yih.[65] Therefore, Shi You *gui* and *pan* are most reasonably placed in the reign of King Gong or Yih. The inscription date of Shi You *pan* is incompatible with the putative *yuan* of King Gong (906, 911, or 917 B.C.E.), but highly compatible with the inscription date of Shi Hu *gui* (Table S8). Therefore, Shi You *pan* is placed in King Yih's reign, implying that Scribe Qiang lived at least until King Yih's fourth year.

Qiang's son is Xing 癲 (see n. 65), the donor of Xing *xu* 癲盨 (no. 21). The inscription of Xing *xu* states that the vessel was made for Xing's deceased father (用作文考寶簋), implying that Qiang had died at the time of inscription. Xing *xu* must therefore be later than Shi You *pan*. The inscription dates of both vessels are in the fourth year. However, the inscription date of Xing *xu* is in the second month, whereas that of Shi You *pan* is in the third month. Therefore, Xing *xu* cannot be placed in King Yih's reign along with Shi You *pan*, and must be placed in the reign of King Xiao or Yi.

In the Xing *xu* inscription, Sima Gong 司馬共 serves as Xing's right-hand convoy. Sima Gong also serves as right-hand convoy in the inscriptions of Shi Chen *ding* 師晨鼎, Shi Yu *gui* 師俞簋, and Jian *gui* 諫簋 (nos. 16, 17, 27). Moreover, in all four inscriptions, the king's reception takes place in Shi Lu palace 師汞宮. These common features strongly suggest that all four vessels are from the same reign.[66] In the Shi Chen *ding*

64. Zhang Changshou, "Shiyou ding he Shiyou pan" 師酉鼎和師酉盤, in Zhongguo shehui kexueyuan kaogu yanjiusuo, ed., *Xinshiji de Zhongguo kaoguxue: Wang Zhongshu xiansheng bashi huadan jinian lunwenji* 新世紀的中國考古學：王仲殊先生八十華誕紀念論文集 (Beijing: Kexue, 2005), 395–401.

65. Shaanxi Zhouyuan kaogudui, "Shaanxi Fufeng Zhuangbai yihao Xi-Zhou qingtongqi jiaocang fajue jianbao" 陝西扶風莊白一號西周青銅器窖藏發掘簡報, *Wenwu* 1978.3, 1–18, 98–104.

66. Shirakawa Shizuka 白川靜, *Shirakawa Shizuka chosakushū: bekkan kinbun tsūshaku* 白川靜著作集：別卷金文通釈, vol. 6 (Tokyo: Heibonsha, 2004), 373–81.

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Table 4. Summary of Individuals Mentioned in Inscriptions

Vessel	Reign	Yr.	Wei 微 Lineage	Sufu	Mentions
9th yr. Wei *ding*	Mu	9			
27th yr. Wei *gui*	Mu	27			
Hu *gui*	Mu	30			
Shi You *gui*	Gong	1	Scribe Qiang		
Qiu Wei *he*	Gong	3			
5th yr. Wei *ding*	Gong	5		Bo Sufu	King Gong
15th yr. Que Cao *ding*	Gong	15			King Gong
Shi Hu *gui*	Yih	1			
Shi You *pan*	Yih	4	Qiang		
Shi Chen *ding*	Xiao	3		Shi Sufu	Sima Gong
Shi Yu *gui*	Xiao	3			Sima Gong
Xing *xu*	Xiao	4	Xing		Sima Gong
Jian *gui*	Xiao	5			Sima Gong

inscription, Shi Chen is commanded by the king to assist Shi Sufu 師俗父, who is identified with Bo Sufu 伯俗父 from the fifth year Wei *ding* inscription. Because fifth year Wei *ding* has been placed in King Gong's reign, the most reasonable placement of Shi Chen *ding*, Xing *xu*, Shi Yu *gui*, and Jian *gui* is in King Xiao's reign (Table 4).

SOLUTION

According to the inscription date of Shi Xun *gui*, the latest possible *yuan* for King Yi is 879 B.C.E. Since the inscription date of Jian *gui* is in King Xiao's fifth year, King Xiao's *yuan* must be no later than 884 B.C.E. (and also no earlier than 889 B.C.E.). Between 889 and 884 B.C.E., the dates of Hu *ding* and Xing *xu* have a unique common solution: 887 B.C.E. This is King Xiao's *yuan* (Table S8). King Xiao ruled for at least five years, meaning that King Yi's *yuan* is no earlier than 882 B.C.E. To accommodate the inscription date of Shi Xun *gui*, King Yi's *yuan* can only be 881, 880, or 879 B.C.E. (Table S8).

King Yih reigned for at least ten years. Therefore, King Yih's *yuan* must be no later than 897 B.C.E. (and no earlier than 902 B.C.E.). To accommodate the inscription date of Shi Hu *gui*, King Yih's *yuan* can only be 899 or 898 B.C.E. Notably, the *Bamboo Annals* states that the day dawned twice at Zheng (天再旦于鄭) in King Yih's *yuan*.[67] Liu Chaoyang first interpreted this entry as a solar eclipse,[68] and Pang Sunjoo 方善柱 further suggested

67. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 55.

68. Liu Chaoyang, "Yinmo Zhouchu riyueshi chukao" 殷末周初日月食初考, in *Liu Chaoyang Zhongguo tianwenxueshi lunwen xuan*, 176–86.

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that this eclipse was an annular eclipse occurring at dawn in central China in 899 B.C.E.,[69] although the interpretation of the "double dawn" as the result of a solar eclipse is not universally accepted.[70] However, since the possibility that the "double dawn" resulted from a solar eclipse cannot be completely excluded, this study favors 899 over 898 B.C.E. as King Yih's *yuan*.

King Gong ruled for at least fifteen years, meaning that his *yuan* must be no later than 914 B.C.E. Therefore, King Gong's *yuan* can only be 917 B.C.E. King Mu ruled for at least thirty-seven years, meaning his *yuan* must be no later than 954 B.C.E. King Mu's *yuan* thus can only be 957 B.C.E.

VALIDATION

Apart from the ten complete inscription dates used to derive the absolute dates of Kings Mu, Gong, Yih, Xiao, and Yi, Appendix A contains twelve additional dates from the middle period that are neither associated with *chuji* nor in the thirteenth month: those of Shi Ju *gui* 師遽簋, Da *xu* 達盨, Taishi Cuo *gui* 太師虘簋, Zou *gui* 走簋, Shi Shan *pan* 士山盤, Zouma Xiu *pan* 走馬休盤, Geng Ying *ding* 庚贏鼎, Dian *gui* 典簋, Lu *gui* 親簋, Jin *gui* 斮簋, Zuoce Wu *he* 作冊吳盉, and Xian *gui* 鮮簋 (nos. 17, 20, 40, 42, 51, 56–59, 65, 68, 73). These additional dates are used to validate the derived dates of middle Western Zhou (Tables 5 and S9).

All the dates except those of Dian *gui*, Lu *gui*, and Xian *gui* (nos. 58, 59, 73) could be accommodated by at least one of the reigns of Kings Mu, Gong, Yih, Xiao, or Yi (Tables 5 and S9). Notably, in the inscription of Xian *gui*, the king offers sacrifice to King Zhao in the capital (王在莽京, 禘於昭王). Therefore, King Zhao must have died at the time of inscription. The inscription records a date in the thirty-fourth year, leading many to place the vessel in King Mu's reign.[71] However, the inscription date of Xian *gui* is incompatible with King Mu's derived *yuan* of 957 B.C.E.

If the thirty-fourth year in the Xian *gui* inscription is not King Mu's regnal year, then it can only be King Zhao's final year. In this scenario,

69. Pang Sunjoo, "Xi-Zhou niandaixue shang de jige wenti" 西周年代學上的幾個問題, *Dalu zazhi* 大陸雜誌 51.1 (1975), 15–23.

70. F. Richard Stephenson, "A Re-investigation of the 'Double Dawn' Event Recorded in the Bamboo Annals," *The Quarterly Journal of the Royal Astronomical Society* 33.2 (1992), 91–98.

71. Huang Shengzhang, "Mushi biaozhunqi—Xian pan de faxian jiqi xiangguan wenti" 穆世標準器——鮮盤的發現及其相關問題, in Sichuan daxue lishixi, ed., *Xu Zhongshu xiansheng jiushi shouchen jinian wenji* 徐中舒先生九十壽辰紀念文集 (Chengdu: Bashu, 1990), 23–52; Li Xueqin and Ai Lan 艾蘭 (Saran Allan), "Xian gui de chubu yanjiu" 鮮簋的初步研究, *Zhongguo wenwubao* 中國文物報 (Beijing), Feb. 22, 1990.

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Table 5. Summarized Chronology of Middle Western Zhou

B.C.E.	King	Yr.	Vessel / Date	No.	Used for	Note
991	Zhao	1				
968		24	Dian *gui*	**58**	Validation	
			Lu *gui*	**59**	Validation	
958		34	Xian *gui*	**73**	**Calculation**	Final year of reign
957	Mu	1				
949		9	9th yr. Wei *ding*	**36**	**Calculation**	
946		12	Zou *gui*	**42**	Validation	Non-unique solution
938		20	Zouma Xiu *pan*	**56**	Validation	
936		22	Geng Ying *ding*	**57**	Validation	
931		27	27th yr. Wei *gui*	**64**	**Calculation**	
930		28	Jin *gui*	**65**	Validation	
928		30	Zuoce Wu *he*	**68**	Validation	
918		40				Final year of reign
917	Gong	1				
915		3	Qiu Wei *he*	**14**	**Calculation**	
906		12	Taishi Cuo *gui*	**40**	Validation	
903		15	15th yr. Que Cao *ding*	**48**	**Calculation**	
902		16	Shi Shan *pan*	**51**	Validation	
900		18				Final year of reign
899	Yih	1	Shi Hu *gui*	**6**	**Calculation**	Non-unique solution
897		3	Shi Ju *gui*	**17**	Validation	Non-unique solution
896		4	Shi You *pan*	**22**	**Calculation**	Non-unique solution

Table 5. Summarized Chronology of Middle Western Zhou

B.C.E.	King	Yr.	Vessel / Date	No.	Used for	Note
888		12	Hu *ding*	**7b**	**Calculation**	Final year of reign
887	Xiao	1	Hu *ding*	**7a**	**Calculation**	
885		3	Da *xu*	**20**	Validation	Non-unique solution
884		4	Xing *xu*	**21**	**Calculation**	
882		6				Final year of reign
881	Yi	1	Shi Xun *gui*	**2**	**Calculation**	Non-unique solution
871		11				Final year of reign

King Mu had succeeded the throne after King Zhao's death, but had not yet started his own regnal year count. Indeed, the inscription date of Xian *gui* fits in the year before King Mu's *yuan* (Table S9), which puts King Zhao's *yuan* at 991 B.C.E. King Zhao's reign can accommodate the dates of Dian *gui* and Lu *gui* as well (Tables 5 and S9).

Thus, all twelve dates have now been accounted for, validating the dates of Kings Zhao, Mu, Gong, Yih, and Xiao. Additionally, 881 B.C.E. is chosen as King Yi's *yuan* to minimize the error.

The Dates of Early Western Zhou

ZHOU'S RECEIPT OF THE MANDATE

The *Bamboo Annals* counts exactly 100 years from Zhou's receipt of the Mandate to King Mu (see n. 58). From the text alone, it is uncertain whether the year count ends in King Mu's *yuan* or final year. However, the previous section determined that Kings Zhao and Mu reigned for thirty-four and forty years, respectively, whereas the reigns of Kings Cheng 成王 and Kang 康王 combined for at least forty years according to the *Bamboo Annals*.[72] The sum of these numbers already exceed 100. Therefore, the 100 years cannot include King Mu's reign, and thus must be counted to King Mu's *yuan*.

King Mu's *yuan* is 957 B.C.E. Counting backward 100 years yields 1056 B.C.E. by inclusive counting, which is the year that Zhou received the Mandate. Western Zhou texts and inscriptions always credit King Wen 文王 with receiving the Mandate, either alone or along with King Wu 武王. Therefore, King Wen must have been in power when Zhou received the Mandate.

KING CHENG

According to the *Bamboo Annals*, Kings Cheng and Kang maintained a period of prolonged peace totaling at least 40 years (see n. 72). Since King Zhao's reign started in 991 B.C.E., the last military operation in King Cheng's reign must be no later than 1031 B.C.E. "Bi shi" 費誓 records a speech given by the Marquis of Lu 魯侯 prior to a military campaign,[73] which *Shi ji* attributes to Boqin 伯禽, the first Marquis of Lu and son of the Duke of Zhou.[74] According to *Shang shu*, King Cheng was young when King Wu died. The Duke of Zhou thus ruled as regent and returned power to King Cheng in the seventh year. Boqin was

72. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 44–45.

73. *Shang shu zhengyi* 尚書正義 (Beijing: Beijing daxue, 2000), 20.660b–65b ("Bi shi" 費誓).

74. *Shi ji*, 33.1844.

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established as marquis at the end of that same year.[75] This means that Boqin's campaign, which can be no later than 1031 B.C.E., must also be no earlier than King Cheng's eighth year.[76] Therefore, King Cheng's *yuan* must be no later than 1038 B.C.E. (and also no earlier than 1056 B.C.E.).

Han shu quotes two dates from "Shao gao":[77]

> It was *jiwang* of the second month, six days after which was *yiwei* (32)
>
> 惟二月既望, 粵六日乙未
>
> In the third month, on the day *bingwu* (43), it was *fei*
>
> 惟三月丙午朏

These dates are presumed to be in the seventh year of the Duke of Zhou's regency, which is also King Cheng's seventh year. The first date uses the lunar phase term *jiwang*, which also appears in bronze inscriptions. However, whereas in bronze inscriptions *jiwang* governs nearly the entire second half of the month, in "Shao gao" it is clear from context that *jiwang* refers to a specific day. The reason for this discrepancy is unknown, and it is unclear which day *jiwang* refers to in "Shao gao." Therefore, the first date is not used for calculation. The second date uses the lunar phase term *fei*, which is the first visibility of the waxing crescent, usually one or two days after conjunction. Since the meaning of *fei* is better understood, the second date is used to compute King Cheng's *yuan*. Between 1038 and 1056 B.C.E., King Cheng's *yuan* has a unique solution: 1042 B.C.E.

JIWANG IN TEXTS AND INSCRIPTIONS

If King Cheng's *yuan* is 1042 B.C.E., then the dates of "Shao gao" are in 1036 B.C.E., which is calendar year 115 of the reference calendar (Table S1). It is now possible to analyze and compare the lunar phases described by *jiwang* in "Shao gao" and in bronze inscriptions. The third month of calendar year 115 contains *bingwu* 丙午 (43) only if the year begins in the month of *hai* 亥 or *chou* 丑. In both cases, *bingwu* is two days after conjunction. The lunar phase of *bingwu* is *fei*, which is the day the

75. *Shang shu zhengyi*, 15.476a–94a ("Luo gao" 洛誥).

76. Some have argued that the Duke of Zhou maintained a separate year count during his regency. However, the inscriptions of Scribe Qiang *pan* and Lai *pan* do not support this view. This study thus incorporates the Duke of Zhou's regency into King Cheng's reign. For a more in-depth discussion of this topic, see Yang Shengnan 楊升南, "Zhougong shezheng wei chengwang" 周公攝政未稱王, *Luoyang shifan xueyuan xuebao* 洛陽師範學院學報 31.1 (2012), 30–39.

77. *Han shu*, 21.1016 ("Shi jing").

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waxing crescent is first sighted. This also implies that the waxing crescent was not observed the previous day (*yisi* 乙巳 [42]).

The visibility of the lunar crescent cannot be predicted with complete certainty. Instead, it is evaluated by empirical criteria derived from observational data. To date, multiple criteria have been proposed. This study adopts Odeh's criterion,[78] which has been peer reviewed, and was derived from observations of both the waxing as well as waning crescent (Table S10, see Supplementary Text for details of implementation).[79]

If calendar year 115 begins with the month of *hai*, the visibility of the waxing crescent is uncertain for *yisi* of the third month (Table S10, Julian day number [JDN] 1343031+1). However, if the year begins with the month of *chou*, the waxing crescent is definitely visible on *yisi* (42) of the third month (Table S10, JDN 1343091+1). Therefore, in order for *bingwu* (43) to be the first visibility of the lunar crescent, the first month of calendar year 115 must be *hai*.

According to "Shao gao," *jiwang* of the second month is *gengyin* 庚寅 (27). If calendar year 115 begins in the month of *hai*, then *gengyin* of the second month is the day after the full moon. *Jiwang* in "Shao gao" is thus the first day of the time period governed by *jiwang* in bronze inscriptions.

JISIBA IS AT THE BEGINNING OF THE MONTH

Wang Shengli proposed that the first day of *jishengba* marked the start of the calendar month, which would make *fei* the last day of the month (see n. 36). However, the dates of "Shao gao" do not support his hypothesis, as *fei* is clearly near the beginning of the third month. If the historical Western Zhou calendar was observational, then the calendar month could not have started with *shuo*. If the calendar day did not start at sunset, then the calendar month could not have started with *fei*. The only remaining option for the beginning of the month would be the first invisibility of the waning crescent, which is the first day of *jisiba* in bronze inscriptions.[80]

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78. Mohammad Sh. Odeh, "New Criterion for Lunar Crescent Visibility," *Experimental Astronomy* 18 (2004), 39–64.

79. The values in Table S10 were calculated for an observer based in Xi'an. The events in "Shao gao" happened near modern day Luoyang 洛陽. Compared to Xi'an, Luoyang has nearly identical latitude, but lies further east. The sun sets earlier in Luoyang, which means the illuminated fraction of the moon around sunset is smaller in Luoyang compared to Xi'an. Therefore, a waxing crescent invisible in Xi'an will not be seen in Luoyang either.

80. Ancient Egypt, where the calendar day began at dawn, also employed a lunar calendar in which the calendar month began with the invisibility of the waning

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Computation of absolute dates in earlier sections assumed that the calendar month began with *jishengba*. Adjusting the beginning of the month to *jisiba* would not affect the results for inscription dates using *jishengba* or *jiwang*. For *jisiba* dates, this adjustment would only change whether the search results in the reference calendar differed from the inscription date by one month or not. Therefore, the previously derived dates remain valid.

KING KANG

Han shu quotes from "Bi ming feng xing" a date presumed to be in King Kang's reign:[81] "In the sixth month of the twelfth year, on the day *gengwu* (7), it was *fei*" (惟十有二年六月庚午朏). Additionally, the inscription date of the Lesser Yu *ding* 小盂鼎 (no. 60) is the sole remaining unused complete inscription date not associated with *chuji* or in the thirteenth month. The Lesser Yu *ding* inscription records the ruling king offering animal sacrifices to the Zhou Kings Wu and Cheng (用牲禘周王武王成王), which places the inscription date of Lesser Yu *ding* after King Cheng's death. Therefore, this vessel is believed to belong to the reign of King Kang or Zhao.

However, the dates of "Bi ming feng xing" and the Lesser Yu *ding* are incompatible (Table S11), therefore they cannot both fit into King Kang's reign. Notably, the inscription date of Lesser Yu *ding* is compatible with King Cheng's *yuan*. With the precedent of Xian *gui*, the possibility that the inscription date of Lesser Yu *ding* is in King Cheng's final year must be considered. However, if King Cheng ruled for twenty-five years, then King Kang's *yuan* must be 1017 B.C.E., which is incompatible with the date of "Bi ming feng xing." Therefore, Lesser Yu *ding* cannot be placed in King Cheng's reign, and is instead placed in King Zhao's reign.

The Lesser Yu *ding* inscription records sacrificial and award ceremonies following a successful military campaign. Placement of this vessel in King Zhao's reign is thus consistent with the account in the *Bamboo Annals* of Kings Cheng and Kang presiding over a prolonged period of peace (see n. 72). Additionally, recent analyses of the style and content of the Lesser Yu *ding* inscription suggest that the vessel belongs to the middle period rather than the early period.[82] The placement of Lesser

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crescent. See Richard A. Parker, *The Calendars of Ancient Egypt*, Studies in Ancient Oriental Civilization, vol. 26 (Chicago: University of Chicago Press, 1950), 9–23.

81. *Han shu*, 21.1017 ("Shi jing"). The original text reads "惟十月二年六月庚午朏." "十月二年" (ten months two years) is clearly a transcriptional error for "十有二年" (the twelfth year).

82. Li Shan 李山 and Li Hui 李輝, "Daxiao Yuding zhizuo niandai Kangwang shuo zhiyi" 大小盂鼎製作年代康王說質疑, *Beijing shifan daxue xuebao* 北京師範大學學報

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Yu *ding* one year after the middle period vessels Dian *gui* and Lu *gui* (nos. 58, 59, both in King Zhao's twenty-fourth year) is consistent with this view.

King Kang's *yuan* must be earlier than 991 B.C.E. (King Zhao's *yuan*) and later than 1036 B.C.E. (the end of the Duke of Zhou's regency). Possible candidates include 1000, 1005, 1010, and 1031 B.C.E. (Table S11). 1031 B.C.E. is discarded because it is too early, being only five years after King Cheng regained power. In *Zuo zhuan*, the Viscount of Chu 楚子 recounts the history of his state: "In the past our former king Xiong Yi, along with Lü Ji, Wangsun Mou, Xiefu, and Qinfu, all served King Kang" (昔我先王熊繹, 與呂伋, 王孫牟, 燮父, 禽父, 並事康王).[83] Qinfu refers to Boqin, the first Marquis of Lu. *Shi ji* records the reign length of each ruler of Lu except Boqin.[84] Based on this information, the *yuan* of Boqin's successor, Lord Kao 考公, is determined to be 1007 B.C.E. (see Table 9, details of derivation can be found below, in "Revising the Chronology of *Shi Ji*"). If Boqin served King Kang, then King Kang's *yuan* must be earlier than 1007 B.C.E., which can only be 1010 B.C.E.

The Zhou Conquest of Shang

ACCORDING TO THE *BAMBOO ANNALS*

The *Bamboo Annals* states that "In the eleventh year, *gengyin* (27), Zhou began its expedition against Shang" (十一年庚寅, 周始伐商).[85] However, the text does not specify the starting point from which the eleventh year is counted. The *Bamboo Annals* contains three statements related to the total years of Western Zhou:[86]

> From King Wu's extermination of Shang, to King You, there are a total of 257 years
>
> 自武王滅殷, 以至於幽王, 凡二百五十七年

2012.2, 31–36; Maria Khayutina, "The Beginning of Cultural Memory Production in China and the Memory Policy of the Zhou Royal House During the Western Zhou Period," *Early China* 44 (2021), 19–108. The Lesser Yu *ding* has been lost to history. Its inscription is known to us only through a barely legible rubbing. This study follows two recent compendia and reads the regnal year inscribed on the Lesser Yu *ding* as the twenty-fifth year. However, some scholars read the regnal year as the thirty-fifth year, which is incompatible with the dates of Western Zhou derived in this study.

83. *Chun qiu zuo zhuan zhengyi*, 45.1501a–2a (Zhao 12).

84. *Shi ji*, 33.1845–48.

85. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 42. Tang Lan 唐蘭 points out that "*gengyin*" 庚寅 is not part of the original text, see Tang Lan, "Zhongguo gudai lishishang de niandai wenti" 中國古代歷史上的年代問題, *Xin jianshe* 新建設 1955.3, 48–51, 44.

86. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 64.

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Western Zhou lasted for 257 years

西周二百五十七年

From King Wu to King You there are 257 years

自武王至幽王二百五十七年

By inclusive counting, King Cheng's *yuan* to King You's final year already spans 263 years (1042–780 B.C.E.). Therefore, the total duration of Western Zhou exceeds 257 years. However, the 257 years is alternatively described as the total years from King Wu's extermination of Shang (武王滅殷) to King You, which may not be equivalent to the total years of Western Zhou. A similar statement counting 100 years "from Zhou's receipt of the Mandate to King Mu" (see n. 58) was shown to end the year count in King Mu's *yuan*. If the 257 years are likewise counted to King You's *yuan*, then the year count would start in 1046 B.C.E. Notably, 1046 B.C.E. is also the eleventh year counting from the year Zhou received the Mandate (1056 B.C.E.).

Therefore, the *Bamboo Annals* suggests 1046 B.C.E. as the year of the conquest, and supports the traditional view that King Wen established a new *yuan* upon receiving the Mandate whereas King Wu continued using King Wen's calendar without establishing his own *yuan*.

ACCORDING TO "WU CHENG" AND "SHI FU"

Han shu quotes three dates from "Wu cheng":[87]

In the first month, on the day *renchen* (29), it was *pangsiba*, the next day, which was *guisi* (30), King Wu left Zhou on foot in the morning to campaign against Zhòu

惟一月壬辰, 旁死霸, 若翌日癸巳, 武王乃朝步自周, 于征伐紂

Subsequently in the second month, it was *jisiba*, five days later, which was *jiazi* (1), he completely defeated the Shang king Zhòu

粵若來二月, 既死霸, 粵五日甲子, 咸劉商王紂

In the fourth month, it was *jipangshengba*, six days later, which was *gengxu* (47), King Wu made a burning sacrifice in the Zhou Temple; the next day, which was *xinhai* (48), he made offerings at the altar to Heaven; five days later, which was *yimao* (52), along with numerous

87. *Han shu*, 21.1015–16 ("Shi jing"). The text quotes the day of *jisiba* to be in the third month, but from context it is clear that this day is in the second month.

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states, King Wu offered the severed ears of the enemy as sacrifice in the Zhou Temple

惟四月既旁生霸, 粤六日庚戌, 武王燎于周廟; 翌日辛亥, 祀于天位; 粤五日乙卯, 乃以庶國祀馘于周廟

"Shi fu" also contains three similar dates:[88]

In the first month, on the day *bingchen* (53), it was *pangshengba*, the next day, which was *dingsi* (54), the king left Zhou on foot to campaign against the Shang king Zhòu

惟一月丙辰旁生魄, 若翼日丁巳, 王乃步自于周征伐商王紂

Subsequently in the second month, it was *jisiba*, five days later, which was *jiazi* (1), in the morning he arrived and engaged the Shang, and completely defeated the Shang king Zhòu

越若來二月, 既死魄, 越五日甲子, 朝至接于商, 則咸劉商王紂

In the fourth month, it was *jipangshengba*, six days later, which was *gengxu* (47), King Wu arrived in the morning and made a burning offer in the Zhou Temple … The next day, which was *xinhai* (48), the king made sacrifice at the altar, using ritual dancers at the altar to Heaven; five days later, which was *yimao* (52), King Wu then, along with numerous states, offered the severed ears of the enemy as sacrifice in the Zhou Temple

時四月既旁生魄, 越六日庚戌, 武王朝至燎于周 … 若翼日辛亥, 祀于位用酋于天位; 越五日乙卯, 武王乃以庶國祀馘于周廟[89]

Between the dates of "Wu cheng" and "Shi fu," there are four specialized terms: *pangsiba*, *pangshengba*, *jisiba*, and *jipangshengba*. Among these terms, only the meaning of *jisiba* is somewhat known: in bronze inscriptions, *jisiba* governs the two to three days of the lunar cycle when the moon is invisible. However, in the cited texts, it is clear that *jisiba* refers to a specific day. Therefore, drawing on the example of *jiwang* in

88. *Yizhoushu huijiao jizhu* 逸周書彙校集注, ed. Huang Huaixin 黃懷信, Zhang Maorong 張懋鎔, and Tian Xudong 田旭東 (Shanghai: Shanghai guji, 2007), 4.412–41 ("Shi fu jie" 世俘解). For an English translation, see Shaughnessy, "'New' Evidence on the Zhou Conquest."

89. The original text reads "以庶祀馘于國周廟," the character order is rearranged according to "Wu cheng." 霸 and 魄 are alternative transcriptions of the same archaic character. In Mandarin they are pronounced bà and pò, respectively. For consistency, both will be Romanized as *ba* when referring to the lunar phase.

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"Shao gao," *jisiba* in "Wu cheng" and "Shi fu" is interpreted as the first day of the time period governed by *jisiba* in bronze inscriptions—the first invisibility of the waning crescent (i.e. *hui* or *shuo*). The second date is thus chosen to compute the year of the conquest. However, in order to effectively utilize this information, the dates of "Wu cheng" and "Shi fu" require further analysis.

The first date of "Wu cheng" and "Shi fu" differ significantly (the reason for this discrepancy will be discussed below). The second and third dates of "Wu cheng" and "Shi fu" are identical. However, the two dates seem to be in conflict. In the second date, *jisiba* of the second month is *gengshen* 庚申 (57). In the third date, *jipangshengba* of the fourth month is *yisi* 乙巳 (42), which is at least forty-five days (about a month and a half) after *gengshen*. Being *jisiba*, *gengshen* is at the beginning of the second month, which means that *yisi* cannot be in the fourth month (it should be around the middle of the third month). In addition, "Shi fu" documents multiple intervening dates between the second and third date, further complicating matters.

If the intervening dates in "Shi fu" are assumed to appear in temporal order, this results in a long interval of 105 days between the second and third date (Table 6; *ganzhi* dates are grouped by ten-day *xun* 旬 for convenience). It might have been this same information that prompted Liu Xin to insert an intercalary month between the second and third month in his attempt to reconcile the second and third date of "Wu cheng": The insertion of an intercalary month results in a 105-day interval between *gengshen* and *yisi*. If *gengshen* is near the start of the second

Table 6. The Intervening Dates of "Shi Fu": Long Interval Arrangement

Xun	*Ganzhi* Dates	Note
1	(57)	*Gengshen* (57) is *jisiba* of the second month.
2	(1), (4), (5), (9)	Shang is defeated on *jiazi* 甲子 (1).
3	(18)	
4	(21)	
5		
6	(48), (49), (50)	*Guiyou* 癸酉 (10) corrected to *guichou* 癸丑 (50).
7	(51), (52)	
8		
9		
10		
11	(37)	Chen Ben 陳本 et al. ordered to attack Shang allies.
12	(42), (47), (48)	*Yisi* (42) is *jipangshengba* of the fourth month.
13	(52)	

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month, then *yisi* is in the fourth month.[90] However, excavated bronze inscriptions indicate that the intercalary month was inserted at the end of the calendar year throughout Western Zhou, thus refuting Liu Xin's proposal.

Gu Jiegang 顧頡剛 and Zhou Fagao (Chou Fa-kao) 周法高 proposed that the fourth month in "Shi fu" is a mistranscription of the sixth month, caused by the similarity between the archaic forms of four () and six ().[91] However, if *yisi* (42) is in the sixth month and *gengshen* (57) is in the second month, then *gengshen* must be in the second half of the month, inconsistent with *jisiba* being at the beginning of the calendar month. Therefore, this proposal is rejected.

Chen Yigang 陳以鋼 proposed that the first and second months of "Shi fu" and "Wu cheng" followed an ad hoc calendar that began when King Wu started his military campaign, whereas the fourth month followed the Zhou calendar with the calendar year beginning in the month of *zi*. Shaughnessy proposed a similar solution, assuming that King Wu established a new calendar and proclaimed the beginning of a new year in the month following his victory over the Shang.[92] Chen Yigang and Shaughnessy differ chiefly in their interpretation of *jisiba*: Chen Yigang follows Liu Xin's interpretation equating *jisiba* with *shuo*, whereas Shaughnessy uses Wang Guowei's interpretation. Shaughnessy's proposal is incompatible with the meaning of *jisiba* deduced by this study, and is thus rejected. On the other hand, Chen Yigang's proposal is compatible with this study.

Kong Guangsen 孔廣森 noticed that "Shi fu" separately documents two sets of sacrificial ceremonies occurring on *xinhai* 辛亥 (48) and *yimao* 乙卯 (52) (see Table 6, *xun* 6–7 and *xun* 12–13). He believed that, rather than document two sets of sacrifices sixty days apart, "Shi fu" recorded the same set of activities twice. Therefore, he combined these two sets of events, resulting in a short interval of forty-five days between *gengshen* (57) of the second month and *yisi* (42) of the fourth month (Table 7; the combined dates are shown in bold, and dates that are moved up compared to Table 6 are underlined).[93]

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90. *Han shu*, 21.1015–16 ("Shi jing"). Liu Xin assumed that *jisiba* was equivalent to *shuo*.

91. Gu Jiegang, "'*Yizhoushu*: Shi fu pian' jiaozhu, xieding yu pinglun"; Chou Fa-kao, "On the Date of the Chou Conquest of the Shang," *Guoli zhongyang tushuguan guankan* 國立中央圖書館館刊 19.2 (1986), 21–34. For the archaic forms of four and six, see Xu Shen 許慎, *Shuowen jiezi* 說文解字 (Beijing: Zhonghua, 1963), 14.307a–b.

92. Chen Yigang, *Hanzhi wucheng riyue biao* 漢志武成日月表, *Congshu jicheng xubian* 叢書集成續編, vol. 263 (Taipei: Xinwenfeng, 1988), 733–39; Shaughnessy, "'New' Evidence on the Zhou Conquest."

93. Kong Guangsen, *Jingxue zhiyan* 經學卮言, *Xuxiu siku quanshu*, vol. 173, 2.272b–75b. Kong Guangsen also uses Liu Xin's interpretation of *jisiba*.

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Table 7. The Intervening Dates of "Shi Fu": Short Interval Arrangement

Xun	*Ganzhi* Dates	Note
1	(57)	*Gengshen* (57) is *jisiba* of the second month.
2	(1), (4), (5), (9)	Shang is defeated on *jiazi* (1).
3	(18)	
4	(21)	
5	(37)	Chen Ben et al. ordered to attack Shang allies.
6	(42), (47), **(48)**, (49), (50)	*Yisi* (42) is *jipangshengba* of the fourth month.
7	(51), **(52)**	

Kong Guangsen then proposed that *gengshen* was in the second month of the Shang calendar, whereas *yisi* was in the fourth month of the Zhou calendar. Tradition holds that the Shang calendar year began in the month of *chou* 丑 (containing the solar term *dahan* 大寒), whereas the Zhou calendar year began one month earlier in the month of *zi*. *Gengshen* in the second month of the Shang calendar is thus in the third month of the Zhou calendar, which is consistent with *yisi* being in the fourth month of the Zhou calendar, thereby resolving the conflict.

Alternatively, Huang Zhangjian 黃彰健 believed that the fourth month was simply a mistranscription of the third month, because the archaic character for four (三) is very similar to the character for three (三).[94] This proposal is disregarded to avoid altering the evidence.

So far, only the solutions proposed by Chen Yigang and Kong Guangsen are compatible with this study. Chen Yigang allows a long interval of 105 days, whereas Kong Guangsen permits only a short interval of forty-five days. A long interval assumes that the dates in "Shi fu" appear in chronological order. However, this premise is highly dubious. The first *ganzhi* date in "Shi fu" is *yiwei* (32) of the fourth month (四月乙未日). The last *ganzhi* date of the text is *jiazi* (1), the same day that King Wu defeated the Shang, which is in the second month according to the preceding text. These are clear examples of dates in "Shi fu" appearing out of chronological order. Therefore, the intervening *ganzhi* dates between the second and fourth month in "Shi fu" may be out of chronological order as well.

Shaughnessy argues that King Wu inspected the defeated troops of Shang at Muye 牧野 on *jiayin* 甲寅 (51) (in *xun* 7), implying that the first set of sacrifices on *xinhai* (48) and *yimao* (52) (Table 6, *xun* 6–7) occurred

94. Huang Zhangjian, "Shi 'Wu cheng' yu jinwen yuexiang—jian lun 'Jinhou Su bianzhong' ji Wuwang fa Zhou nian" 釋《武成》與金文月相——兼論《晉侯穌編鐘》及武王伐紂年, *Lishi yanjiu* 1998.2, 5–24. The archaic form of four is often seen in oracle bone and bronze inscriptions, see also Xu Shen, *Shuowen jiezi*, 14.307a.

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near the Shang capital and are therefore distinct from the second set of activities (Table 6, *xun* 12–13) that happened after King Wu returned to Zhou, precluding a short interval.[95]

However, the activity on *jiayin* was originally written as 謁我殷于牧野. The character 我 is believed to be the result of textual corruption. Lu Wenchao 盧文弨 changed this line to 謁戎殷于牧野, whereas Zhuang Shuzu 莊述祖 changed it to 謁伐殷于牧野.[96] Regardless of the character chosen to replace 我, this line is commonly seen as documenting a sacrificial ceremony in which King Wu reports to his ancestors and Heaven that "the Shang were defeated at Muye." In this context, the phrase "at Muye" (于牧野) describes the site of Shang's defeat, not King Wu's whereabouts on *jiayin*.

In fact, Li Xueqin argues that the first set of sacrifices must have happened in the Zhou temple. He points out that on the first *xinhai* (48) day (Table 6, *xun* 6), King Wu goes to the temple (格于廟), and reports the crimes of Shang (告殷罪) to his ancestors Tai Wang 太王, Tai Bo 太伯, Wang Ji 王季, Yu Zhong 虞仲, King Wen, and Yi Kao 邑考. Li Xueqin argues that the Shang temple is ill-equipped to host such a ceremony, because it would not have the required spirit tablets of the Zhou ancestors, and it is highly unlikely that King Wu would have brought the tablets with him on the campaign. Therefore, a ceremony involving so many ancestors could only be performed in the Zhou temple.[97]

Considering the overall evidence, this study adopts Kong Guangsen's proposal in favor of a short interval. In doing so, this study makes the additional assumption that the Shang calendar year began one month after the Zhou calendar year. Analysis of oracle bone inscriptions has been inconclusive regarding the beginning of the historical Shang calendar year.[98] If future research demonstrates that the historical Shang calendar year did not begin one month after the historical Western Zhou calendar year, then Kong Guangsen's proposal should be rejected in favor of Huang Zhangjian's proposal.

According to "Wu cheng" and "Shi fu," in the year of the conquest, *jisiba* of the second month of the Shang calendar year was *gengshen* (57).

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95. Shaughnessy, "'New' Evidence on the Zhou Conquest."

96. *Yizhoushu huijiao jizhu*, ed. Huang Huaixin et al., 4.427–28 ("Shi fu jie").

97. Li Xueqin, "'Shi fu' pian yanjiu" 《世俘》篇研究, in *Guwenxian conglun* 古文獻叢論, ed. Wang Yuanhua 王元化 (Shanghai: Shanghai yuandong, 1996), 69–80. According to Sima Qian, King Wu carried King Wen's wooden spirit tablet on a chariot during his campaign against the Shang, see *Shi ji*, 61.2583 ("Bo Yi liezhuan" 伯夷列傳). However, there is no mention of the spirit tablets of the other ancestors.

98. Chang Yuzhi 常玉芝, *Yinshang lifa yanjiu* 殷商曆法研究 (Changchun: Jilin wenshi, 1998), 383–85.

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Therefore, *shuo* of the third month of the Zhou calendar year must be *gengshen* or *xinyou* 辛酉 (58). Between 1056 B.C.E. (Zhou's receipt of the Mandate) and 1042 B.C.E. (King Cheng's *yuan*), the reference calendar contains a unique solution: 1044 B.C.E.

RECONCILING "WU CHENG," "SHI FU," AND THE *BAMBOO ANNALS*

"Wu cheng," "Shi fu," and the *Bamboo Annals* appear to disagree on the year of the conquest. The *Bamboo Annals* suggests the conquest occurred in 1046 B.C.E., whereas the dates of "Wu cheng" and "Shi fu" suggest the conquest happened two years later, in 1044 B.C.E. Notably, according to *Shi ji*, King Wu led an initial campaign against Shang, but stopped short at Mengjin 盟津, where he met with 800 vassal lords (會八百諸侯) and held a military display (*guan bing* 觀兵) before returning to Zhou. Two years later, King Wu led a second expedition that overthrew the Shang.[99] Could the *Bamboo Annals* be referring to King Wu's initial expedition?

The *Bamboo Annals* counts 257 years from King Wu's extermination of Shang to King You, arguing against 1046 B.C.E. as the year of the initial expedition (see n. 86). However, the statements related to the total years of Western Zhou in the *Bamboo Annals* are indirect quotes. This study showed previously that later authors mistook the end point of the 257-year count as King You's final year instead of his *yuan*. The starting point of the 257-year count may also have been misinterpreted.

Notably, the *Bamboo Annals* states that "Zhou *began* its expedition against Shang" (周始伐商; emphasis added) in the eleventh year (see n. 85), supporting 1046 B.C.E. as the year of the initial expedition. Therefore, to reconcile the *Bamboo Annals* with "Wu cheng" and "Shi fu," and imitating the statement counting 100 years "from Zhou's receipt of the Mandate to King Mu" (see n. 58), the original statement related to the total years of Western Zhou is reconstructed as: "From Zhou's campaign against Shang to King You there were 257 years" (自周伐商至幽王二百五十七年).

Later scholars likely equated the "campaign against Shang" (*fa Shang* 伐商) with the "extermination of Shang" (*mie Yin* 滅殷), and thus expressed the starting point of the 257-year count as "King Wu's extermination of Shang." Later scholars also likely further assumed that King Wu established *yuan* in the year of the conquest and further simplified the expression to "King Wu." The year count was then assumed to end in King You's final year, leading to the belief that Western Zhou had a total of 257 years.

99. *Shi ji*, 4.157. Mengjin 盟津 is alternatively written as 孟津.

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Therefore, this study concludes that 1046 B.C.E. is the year of King Wu's initial expedition, and 1044 B.C.E. is the year of the conquest. This conclusion supports the traditional narrative of King Wu holding a military display at Mengjin (觀兵孟津) two years before defeating Shang.

FURTHER ANALYSIS OF THE DATES OF "WU CHENG" AND "SHI FU"

According to the second date of "Wu cheng" and "Shi fu," *gengshen* (57) of the third month (in the Zhou calendar) of the conquest year (1044 B.C.E., calendar year 107) is the first invisibility of the waning crescent, implying that the crescent was observed the day before, on *jiwei* 己未 (56). To accommodate the dates of "Wu cheng" and "Shi fu," calendar year 107 must begin with the month of *hai* or *chou* (Table S1). In either case, the waning crescent is invisible on *gengshen* (57) (Table S10, JDN 1340108–1 and 1340167). On *jiwei* (56), the waning crescent is certainly visible if the year begins with the month of *hai* (Table S10, JDN 1340108–2), but may be invisible if the year begins with the month of *chou* (Table S10, JDN 1340167–1).

Therefore, the year of the conquest began with the month of *hai*. In this case, *renchen* (29) of the first month (in the Shang calendar, the second month in the Zhou calendar) was the day after the new moon, which is *pangsiba* according to "Wu cheng"; *yisi* (42) of the fourth month (in the Zhou calendar) was the day of the full moon, which is *jipangshengba* according to "Wu cheng" and "Shi fu" (Table S1).

"Wu cheng" states that King Wu left Zhou on *guisi* (30) and arrived in the outskirts of Shang on *jiazi* (1). But according to "Shi fu," King Wu left on *dingsi* (54) and arrived seven days later on *jiazi*. Considering the distance from Zhou to Shang, the dates of "Wu cheng" are much more realistic. Therefore, the *ganzhi* and lunar phase of the first date of "Shi fu" are generally seen as erroneous. However, now that King Wu is shown to have led two expeditions against Shang, is it possible that the first date of "Shi fu" is in the year of the initial expedition instead of the conquest year?

If the first date of "Shi fu" was two years earlier than the dates of "Wu cheng," it must have also used the Shang calendar. Since the first date of "Shi fu" and "Wu cheng" are both in the first month of the Shang calendar, they must be twenty-four or twenty-five months apart, assuming no consecutive intercalary years. The twenty-fourth month before the first date of "Wu cheng" (by exclusive counting) contains *bingchen* (53), which is the day before the full moon (Table S1). According to "Shi fu," this day is *pangshengba*, which is one day before *jipangshengba* in the lunar cycle. The lunar phase relationship between *pangshengba* and *jipangshengba* thus agrees with the literal interpretation of *jipangshengba*

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as "after *pangshengba*," supporting the placement of the first date of "Shi fu" in the year of the initial expedition, and showing that it is compatible with the dates of "Wu cheng."

Validation of the Derived Chronology

Non-*Chuji* Dates in the Thirteenth Month

Although the inscription dates of both Mu *gui* 牧簋 and Wu Hu *ding* 吳虎鼎 (nos. 34, 54) use the term *jishengba*, they were omitted from earlier analysis because they are in the thirteenth month. This section now examines their placement to further validate the derived chronology.

THE PLACEMENT OF MU *GUI*

The inscription date of Mu *gui* is seventh year, thirteenth month, *jishengba*, *jiayin* (51). The vessel is dated to the middle period of Western Zhou. In the inscription, the king calls out Interior Scribe Wu 內史吳, who also appears in Shi Hu *gui* inscription. Since Shi Hu *gui* has been placed in King Yih's reign, the most suitable placement for Mu *gui* is in the reign of King Gong or Yih.

King Gong's seventh year (911 B.C.E., calendar year 240) is an intercalary year in the reference calendar (Table S1). If that year begins with the month of *hai* or *chou*, the thirteenth month will contain *jiayin*, but it is five or six days after the full moon, far beyond the range of *jishengba*.

King Yih's seventh year (893 B.C.E., calendar year 258) is not an intercalary year in the reference calendar. However, if the seventh year begins with the month of *zi* and the eighth year begins with the month of *chou*, then the seventh year will have a thirteenth month containing *jiayin*, which is six days after the new moon, within the range of *jishengba*. Mu *gui* is therefore placed in King Yih's reign.

THE PLACEMENT OF WU HU *DING*

The inscription date of Wu Hu *ding* is eighteenth year, thirteenth month, *jishengba*, *bingxu* 丙戌 (23). The vessel is dated to late Western Zhou. In this time period, only Kings Li and Xuan have an eighteenth year. In the Wu Hu *ding* inscription, the king reiterates King Li's command (釐剌王命) when enfeoffing Wu Hu with lands previously held by Wu Ying 吳荂. Therefore, Wu Hu *ding* should be placed in King Xuan's reign.[100]

100. Li Xueqin, "Wuhuding kaoshi—Xia Shang Zhou duandai gongcheng kaoguxue biji" 吳虎鼎考釋——夏商周斷代工程考古學筆記, *Kaogu yu wenwu* 1998.3, 29–31.

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King Xuan's eighteenth year (819 B.C.E., calendar year 332) is an intercalary year in the reference calendar. If that year began with the month of *zi*, then the thirteenth month contains *bingxu* (23), which is two days after the full moon and slightly beyond the range of *jishengba*. The lunar phase error of the inscription date of Wu Hu *ding* thus exceeds the one-day limit imposed by this study. However, given the overall success of the derived chronology in accommodating complete dates from inscriptions and texts, it is highly unlikely that the interpretations of the specialized terms or the derived *yuan* of the Zhou kings are wrong. The lunar phase error of the inscription date of Wu Hu *ding* thus suggests that the Western Zhou calendar was not as accurate as assumed.

The stringent one-day limit for the lunar phase error is based on the belief that the Western Zhou calendar was observational.[101] The lunar phase error of the inscription date of Wu Hu *ding* is thus taken as evidence that the Western Zhou calendar no longer relied purely on observation by King Xuan's eighteenth year. The Lu 魯 calendar documented in *Chun qiu* used *shuo* as the start of the month, and it must therefore be computational. The inscription date of Wu Hu *ding* suggests that the transition from an observational calendar to a computational one was under way in the late stage of Western Zhou. In conclusion, Wu Hu *ding* is placed in King Xuan's reign despite the two-day error.

Chuji Revisited

Previously, *chuji* was hypothesized to be unrelated to the lunar phase, and *chuji* dates were omitted from the initial analysis. Now, having derived the complete chronology of Western Zhou, this section revisits *chuji* to determine its proper interpretation.

THE PROBLEM WITH *CHUJI* DATES

Liu Yu proposed that *chuji* was related to divination and could apply to any day of the month (see n. 31). However, this interpretation of *chuji* runs into problems upon further examination. The third and fourth dates of Jin Hou Su *zhong* (nos. 71c–d) are both in King Xuan's thirty-fourth year (803 B.C.E., calendar year 348). The third date is second month, *jisiba*, *renyin* 壬寅 (39), and the fourth date is sixth month, *chuji*, *wuyin* 戊寅 (15). If *renyin* is in the second month and *wuyin* is in the sixth month, then *wuyin* must be ninety-six days—about three months and seven days—after *renyin*. This means that *wuyin* must be near the beginning of the sixth month, whereas *renyin* must be near the end of the second month. The inscription dates of Jin Hou Su *zhong* thus appear to

101. Zhang Peiyu et al., *Zhongguo gudai lifa*, 164–66.

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imply that *jisiba* is at the end of the month, contradicting "Shao gao," which shows that *fei*—the last day of *jisiba* in bronze inscriptions—is near the beginning of the month.

The inscription dates of Hu *gui* and Zuoce Wu *he* (nos. 67–68) are both in the fourth month of King Mu's thirtieth year (928 B.C.E., calendar year 223).[102] To accommodate the inscription date of Zuoce Wu *he* (*renwu* 壬午 [19]), King Mu's thirtieth year must begin with the month of *zi*. As a result, the new moon of the fourth month is *bingzi* 丙子 (13), two days after the *ganzhi* of Hu *gui*'s inscription date (*jiaxu* 甲戌 [11]). This means that, regardless of the position of *jisiba* in the calendar month, the fourth month of King Mu's thirtieth year does not contain *jiaxu*. The inscription date of Hu *gui* thus cannot fit in King Mu's reign. Therefore, the interpretation of *chuji* must be reconsidered.

CHUJI, DIVINATION, AND THEORETICAL DATES

If *chuji* can describe any day of the month, the same day can always be alternatively described by *jisiba*, *jishengba*, or *jiwang*. Why, then, are some dates described by *chuji*, while others are described by their lunar phase? *Chuji* literally means "initially auspicious." Is it possible that *chuji* indicates auspicious dates, whereas the other terms do not?

Complete inscription dates are frequently associated with formal ceremonies in which the king bestows prestigious titles and valuable gifts on the donor of the vessel. Received texts show that auspicious days for holding such events were selected with great care by divination. If *chuji* exclusively describes auspicious dates, then the dates of these formal ceremonies in bronze inscriptions should all use *chuji*. However, all four specialized terms appear in inscription dates associated with these ceremonies, suggesting that the terms can all describe auspicious dates. Therefore, auspiciousness does not explain the distinction between *chuji* and the other three specialized terms.

Yi li 儀禮 documents the process for selecting by divination an auspicious date for the minister's ancestral sacrificial ceremony (*shaolao kuisi li* 少牢饋食禮). Curiously, although this ceremony prefers days on *ding* 丁 or *ji* 己, the incantation invokes "the coming day (of) *dinghai* (24)" (來日丁亥). According to Zheng Xuan's 鄭玄 commentary, the ceremony

102. Zhang Guangyu 張光裕 documented a bronze lid owned by a private collector with inscriptions nearly identical to that of Hu *gui*. However, the inscription date of the private collector's piece was in the third month, while recording the same regnal year, specialized term, and *ganzhi* as the excavated Hu *gui*. Zhang Guangyu believed this was a result of damage to the mold used to cast the vessel, see Zhang Guangyu, "Hugui jia, yi gaiming hejiao xiaoji" 虎簋甲、乙蓋銘合校小記, *Guwenzi yanjiu* 古文字研究 24 (2002), 183–88.

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is not always held on a *dinghai* 丁亥 day: If the coming *dinghai* day is not auspicious, then a subsequent auspicious day on *ding* will be chosen by divination.[103] Pang Pu 龐朴 believed that, regardless of the true *ganzhi* of the day of the ceremony, the incantation invariably invoked the coming day of *dinghai*. Therefore, he argued that *dinghai* in the incantation is best understood as a general indication of auspiciousness rather than the actual *ganzhi* date of the ceremony, and he proposed that *dinghai* functioned as a theoretical date in this situation (i.e. the invoked *ganzhi* is not necessarily the true *ganzhi*).[104]

A high occurrence of *dinghai* in bronze inscription dates was first noticed by Wang Guowei[105] and later confirmed by systematic analysis of Shang and Zhou bronzes.[106] The clear preference for *dinghai* prompted Pang Pu to propose that *dinghai* in bronze inscription dates may also function as a theoretical date, similar to its role in the incantation of the minister's ancestral sacrificial ceremony (see n. 104).

Five of the complete inscription dates used previously for chronological reconstruction are on *dinghai* (Shi X *gui*, Da *gui*, fifteenth year Da *ding*, Yi *gui*, and forty-third year Lai *ding*; nos. 9, 43, 47, 63, 76). All are true dates, suggesting that *dinghai* is not a theoretical date when associated with *jishengba* or *jiwang* (or, presumably, *jisiba*). This implies that, if *dinghai* can function as a theoretical date, it can only be associated with *chuji*. *Chuji* would thus appear to specifically indicate situations where *dinghai* functioned as a theoretical date.

Dinghai was likely not the only *ganzhi* that could function as a theoretical date, since different ceremonies had different *ganzhi* preferences: The king's ancestral sacrificial ceremony (*di yu taimiao li* 禘於太廟禮) preferred *dinghai*, the minister's ancestral sacrificial ceremony preferred days on *ding* or *ji*, the sacrificial ceremony to the god of soil (*she* 社) preferred days on *jia* 甲, and the suburban offerings (*jiao* 郊) preferred days on *xin* 辛.[107] Presumably, the various ceremonies in the bronze inscriptions also had specific preferences for *ganzhi*. In principle, these preferred *ganzhi* could all function as theoretical dates in a manner similar to *dinghai*, and *chuji* may have specifically indicated this type of usage.

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103. *Yi li zhushu* 儀禮注疏 (Beijing: Beijing daxue, 2000), 47.1036a–38a ("Shaolao kuisi li" 少牢饋食禮).

104. Pang Pu, "'Wuyue bingwu' yu 'zhengyue dinghai'" "五月丙午"與"正月丁亥," *Wenwu* 1979.6, 81–84.

105. Wang Guowei, "Qi Guocha dan ba yi" 齊國差鑾跋一, in *Wang Guowei quanji*, vol. 14, 462.

106. Huang Ranwei 黃然偉, *Yin Zhou qingtongqi shangci mingwen yanjiu* 殷周青銅器賞賜銘文研究 (Hong Kong: Longmen shudian, 1978), 60–69.

107. *Yi li zhushu*, 47.1037a–38a ("Shaolao kuisi li"); *Li ji zhengyi* 禮記正義 (Beijing: Beijing daxue, 2000), 25.917a, 26.927b ("Jiao te sheng" 郊特牲).

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The inscription dates of Fan *you* 鄴卣 (nos. 114a–b) offer a rare opportunity to analyze the true *ganzhi* of a *chuji* date. The Fan *you* inscription records two sacrificial ceremonies: "In the ninth month, *chuji*, on the day *guichou* (50), the lord performed the *rong* ceremony. Eleven days later, on *xinhai* (48), the lord performed the *di* and *rong* ceremonies in honor of Lord Xin" (唯九月初吉癸丑, 公肜祀. 旁旬又一日辛亥, 公禘肜辛公祀).

According to the inscription, the ceremony on *xinhai* occurred eleven days (inclusive) after the ceremony on *guichou*, which contradicts the *ganzhi* sequence. Chen Peifen 陳佩芬 suggested that the eleven days were counted from a hypothetical ceremony not mentioned in the inscription.[108] However, this interpretation lacks supporting evidence. Li Xueqin points out that the true *ganzhi* of the first ceremony is *xinchou* 辛丑 (38) (calculated by counting eleven days [inclusive] back from *xinhai* [48]), and viewed *guichou* (50) as an inscription error.[109] However, this mismatch between the true *ganzhi* and the inscribed *ganzhi* should be seen as evidence that the date in question is a theoretical date. Therefore, the inscription of Fan *you* shows that *guichou* can function as a theoretical date, just like what has been proposed for *dinghai*. Moreover, Fan *you* provides direct evidence that *chuji* can indicate theoretical dates.

Interpreting *chuji* as an exclusive indicator for theoretical dates resolves the difficulties related to the *chuji* dates of Jin Hou Su *zhong* and Hu *gui*, since the inscribed *ganzhi* is not the true *ganzhi*. The distinction between *chuji* and the other three specialized terms also becomes obvious: theoretical dates are indicated by *chuji*, whereas real dates are described by their lunar phase. Therefore, this new interpretation of *chuji* is accepted as the proper meaning of this term.

Placement of the Remaining Inscription Dates

Being theoretical dates, the month and *ganzhi* combination of *chuji* dates can fit into any given year, allowing maximum flexibility for the placement of the dates. However, this flexibility also makes the new interpretation of *chuji* unfalsifiable. Therefore, to formulate a testable hypothesis, additional restrictions must be imposed on the month and *ganzhi* of *chuji* dates.

Notably, for both *chuji* dates of Jin Hou Su *zhong* and Hu *gui*, the month of the inscription date does not contain the associated *ganzhi*.

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108. Chen Peifen, "Fan you, Ma ding ji Liangqi zhong mingwen quanshi" 繁卣、趞鼎及梁其鍾銘文詮釋, *Shanghai bowuguan jikan* 2 (1982), 15–25.

109. See n. 5 of Li Xueqin, "'*Shang shu*' yu '*Yizhoushu*' zhong de yuexiang" 《尚書》與《逸周書》中的月相, in *Xia Shang Zhou niandaixue zhaji* 夏商周年代學札記 (Shenyang: Liaoning daxue, 1999), 125–33.

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This exclusionary relationship between the month and *ganzhi* is thus assumed to apply to all *chuji* dates. This narrower interpretation of *chuji* can be tested if a *chuji* date is placed in a year whose first month is known.

Even with the additional restriction, the placement of *chuji* dates remains highly flexible, rarely resulting in unique solutions. Therefore, auxiliary information was leveraged to further restrict the range of possible solutions. Periodization based on vessel shape and decor, calligraphy style, as well as inscription content provides a rough estimate of age. The same individuals appearing across multiple inscriptions restrict the chronological distance of the relevant vessels. Vessels belonging to separate members from different generations of the same lineage have a defined temporal sequence. If the auxiliary information still could not determine placement, calendrical considerations were taken into account: consecutive intercalary years were avoided, and placement favored years beginning with the month of *zi*.

In the interest of space, this section will only discuss the placement of Ke *bo* 克鎛 (no. 50), due to its implications for the interpretation of *chuji*. In the Ke *bo* inscription, the king is in the Kang Li palace of Zhou 周康剌宮. Tang Lan argued that this was King Li's temple, implying that King Li had died at the time of inscription, thus placing Ke *bo* in King Xuan's reign.[110] The inscription date of Ke *bo* is sixteenth year, ninth month, *chuji*, *gengyin* 庚寅 (27). To exclude *gengyin* from the ninth month, King Xuan's sixteenth year (821 B.C.E., calendar year 330) must begin with the month of *zi*. But King Xuan's sixteenth year must also accommodate Bo Ke *hu* (no. 49), which requires the year to begin in the month of *hai* or *chou* (Table S6). Therefore, if Ke *bo* indeed belongs to King Xuan's reign, then the exclusionary relationship between the month and *ganzhi* for *chuji* dates is rejected.

However, Guo Moruo and Chen Mengjia reject Tang Lan's interpretation of Kang Li palace, maintaining that it was not King Li's temple but rather the name of a building in the royal palace complex.[111] Tang Lan also concedes that the placement of Ke *bo* in King Xuan's reign can be problematic (see n. 110). Ke was also the donor of Shanfu Ke *xu* 膳夫克盨 as well as the Greater and Lesser Ke *ding* 克鼎 (nos. 53, 103, 120). In the Greater Ke *ding* inscription, Shen Ji 豳季 is the right-hand convoy. Shen Ji serves the same function in the Yi *gui* inscription (no. 63), which is in King Li's twenty-seventh year. Ke *bo* is thus most reasonably placed in

110. Tang Lan, "Xi-Zhou tongqi duandai zhong de 'kanggong' wenti" 西周銅器斷代中的"康宮"問題, *Kaogu xuebao* 29 (1962), 15–48.

111. Guo Moruo, *Liang-Zhou jinwenci daxi tulu kaoshi* 兩周金文辭大系圖錄攷釋, vol. 6 (Beijing: Kexue, 1957), 7–8; Chen Mengjia, *Xi-Zhou tongqi duandai*, 36–37.

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King Li's sixteenth year (855 B.C.E., calendar year 296), arguing against the interpretation of Kang Li palace as King Li's temple and preserving the exclusionary relationship between the month and *ganzhi* of *chuji* dates.

All remaining complete *chuji* dates in Appendix A, as well as thirty-one additional dates that include the regnal year (nos. 77–107), were successfully placed in the derived chronology (Appendix B). A summary of individuals appearing across multiple inscriptions is provided in Appendix C.

Validation of Edge Cases

In bronze inscriptions, the lunar cycle is split into three subdivisions: *jisiba*, *jishengba*, and *jiwang*. Any two of these subdivisions share a boundary, and inscription dates that fall on these boundaries are edge cases. This section examines these edge cases as a final validation of the derived chronology.

THE *JIWANG–JISIBA* BOUNDARY

Jisiba begins with the first invisibility of the waning crescent. The moon is presumed to be invisible on *shuo*, but the visibility of the crescent on *hui* is uncertain. Therefore, *jiwang* or *jisiba* dates that fall on *hui* are edge cases. Appendix B contains no such edge cases for *jisiba* dates and three for *jiwang* dates.

While it is possible that an observer failed to see a visible crescent, it is highly unlikely that an invisible crescent was mistakenly sighted. Therefore, for the *jiwang* edge cases, the waning crescent must have been visible.

The inscription date of Zou *gui* (no. 42; twelfth year, third month, *jiwang*, *gengyin* [27]) has been placed in King Mu's twelfth year (946 B.C.E., calendar year 205). That year begins with the month of *zi*, and *gengyin* of the third month falls on *hui*. Sighting of the waning crescent that day was possible, but not certain (Table S10, JDN 1375958–1).

The inscription date of Zouma Xiu *pan* (no. 56; twentieth year, first month, *jiwang*, *jiaxu* [11]) has been placed in King Mu's twentieth year (938 B.C.E., calendar year 213). That year begins with the month of *zi*, and *jiaxu* of the first month falls on *hui*. The lunar crescent was certainly visible that day (Table S10, JDN 1378822–1).

The first inscription date of Hu *ding* (no. 7a; *yuan*, sixth month, *jiwang*, *yihai* 乙亥 [12]) has been placed in King Xiao's *yuan* (887 B.C.E., calendar year 264). That year begins with the month of *zi*, and *yihai* of the sixth month falls on *hui*. The waning crescent was certainly visible that day (Table S10, JDN 1397603–1).

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THE *JISIBA–JISHENGBA* BOUNDARY

The first visibility of the waxing crescent, or *fei*, marks the end of *jisiba*. Since the Western Zhou calendar day began at sunrise and the young crescent can only be seen around sunset, *jishengba* must begin the day after *fei*. The waxing crescent is nearly always visible two days after *shuo*, whereas visibility on the day after *shuo* is uncertain. Therefore, *jisiba* and *jishengba* dates that are two days after *shuo* are edge cases. Appendix B contains no such edge cases for *jisiba* dates and three for *jishengba* dates.

The inscription date of the fifteenth year Que Cao *ding* (no. 48; fifteenth year, fifth month, *jishengba*, *renwu* [19]) has been placed in King Gong's fifteenth year (903 B.C.E., calendar year 248). This year begins with the month of *chou*, and *renwu* of the fifth month is two days after *shuo*. The lunar crescent was certainly visible the previous evening (Table S10, JDN 1391727+1).

The inscription date of Shi You *pan* (no. 22; fourth year, third month, *jishengba*, *jiaxu* [11]) has been placed in King Yih's fourth year (896 B.C.E., calendar year 255). This year begins with the month of *hai*, and *jiaxu* of the third month is two days after *shuo*. The lunar crescent was certainly visible the previous day (Table S10, JDN 1394179+1).

The inscription date of the forty-second year Lai *ding* (no. 75; forty-second, fifth month, *jishengba*, *yimao* [52]) has been placed in King Xuan's forty-second year (795 B.C.E., calendar year 356). This year begins with the month of *chou*, and *yimao* of the fifth month is two days after *shuo*. Sighting of the lunar crescent was possible, but not certain, the previous day (Table S10, JDN 1431180+1).

THE *JISHENGBA–JIWANG* BOUNDARY

Observation of the full moon marked the end of *jishengba*. Since the sun and moon are in opposition, the full moon can only be observed after sunset. In the reference calendar, the new day begins at midnight, whereas in the historical Western Zhou calendar the new day began at sunrise. The full moon, or *wang*, in the reference calendar can thus be the first day of *jiwang* or the last day of *jishengba*. Therefore, *jishengba* or *jiwang* dates that fall on *wang* are edge cases. Appendix B contains no such edge cases for *jishengba* dates and only one for *jiwang* dates.

The inscription date of Huan *pan* (no. 66; twenty-eighth year, fifth month, *jiwang*, *gengyin* [27]) has been placed in King Xuan's twenty-eighth year (809 B.C.E., calendar year 342). This year begins with the month of *zi*, and *gengyin* of the fifth month falls on *wang* (JDN 1426057). The moment of lunar opposition is around 5:58 (Table S1), and the sun rises that day around 5:16 (Xi'an local time). The moon likely already

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appeared full before sunrise on *gengyin*. Therefore, the *gengyin* day of the Western Zhou calendar that started at sunrise becomes the first day of *jiwang*.

STRINGENT VALIDATION

The visibility of the lunar crescent for the inscription dates of Zou *gui* and forty-second year Lai *ding* is uncertain. Therefore, the possibility that the crescent was not observed cannot be completely excluded.

The inscription date of Zou *gui* can alternatively fit in King Gong's reign, where it would not be an edge case (Table S9). The vessel is placed in King Mu's reign because Sima Xing Bo 司馬邢伯, the right-hand convoy in the Zou *gui* inscription, is identified with Sima Xing Bo Lu 親, the right-hand convoy in the inscription of Shi Yun *gui* 師㝬簋 (no. 109). Sima Xing Bo Lu is the donor of Lu *gui* (no. 59),[112] which has been placed in King Zhao's reign. If Zou *gui* is placed in King Gong's reign, then Sima Xing Bo in the Zou *gui* inscription must be a different individual, presumably a descendant of Lu.

The inscription date of the forty-second year Lai *ding* can be alternatively explained as a computation error, since the inscription date of Wu Hu *ding* implies that the calendar no longer relied purely on observation as early as King Xuan's eighteenth year. Computation error may also account for the miniscule lunar phase error of the inscription date of Huan *pan*.

Overall, the complete inscription dates in Appendix B are highly consistent with the lunar phase computed by astronomical methods. To the author's knowledge, the absolute chronology of Western Zhou derived here is the most successful reconstruction to date. It is noteworthy that of the four dates with possible or confirmed lunar phase errors, three are in King Xuan's reign, supporting the notion that the calendar was no longer purely observational by then.

Re-Examining Texts

Revising the Chronology of *Shi Ji*

The derived chronology of Zhou differs significantly from that given in *Shi ji*. This section attempts to reconcile the chronology of the states of Lu 魯, Qi 齊, Wei 衛, Qin 秦, Jin 晉, and Zheng 鄭 in *Shi ji* with the derived chronology. It is assumed that the "Shi'er zhuhou nianbiao"

112. Li Xueqin, "Lun Lugui de niandai" 論親簋的年代, *Zhongguo lishi wenwu* 2006.3, 7–8.

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十二諸侯年表 reflects Sima Qian's synthesis of material available to him, whereas the dedicated *benji* 本紀 or *shijia* 世家 of the relevant states more faithfully preserves primary sources. Internal inconsistencies within or between the various chapters of *Shi ji* are thus clues to where Sima Qian may have altered the original material to produce his chronology. The pre-Qin history texts *Chun qiu*, *Zuo zhuan*, *Xinian*, and the *Bamboo Annals* are also consulted in addition to *Shi ji*.

THE CHRONOLOGY OF LU

"Lu Zhougong shijia" 魯周公世家 states that King You died in Lord Xiao's 孝公 twenty-fifth year, and Lord Xiao ruled for twenty-seven years. However, in "Shi'er zhuhou nianbiao," King You dies in Lord Xiao's thirty-sixth year and Lord Xiao dies in his thirty-eighth year.[113] This discrepancy is due to the inclusion of Boyu's 伯御 eleven-year reign in Lord Xiao's regnal year count, which seems unnecessary.

Why would Sima Qian include Boyu's reign in Lord Xiao's reign at the expense of consistency? The most likely explanation is that Sima Qian saw material that clearly documented King You's death in Lord Xiao's twenty-fifth year, but also explicitly recorded Lord Xiao's regnal year beyond thirty. Since Sima Qian was unaware of the seven-year gap between King You's final year and King Ping's *yuan*, he likely thought the material was contradictory, and "resolved" the issue by including Boyu's reign in Lord Xiao's reign.

Therefore, the chronology of Lu is revised by separating the eleven years of Boyu from Lord Xiao's reign, while maintaining the first year of the Gonghe regency as Lord Zhen's 真公 fifteenth year and preserving the reign lengths of Lords Zhen, Wu 武公, Yi 懿公, and Boyu as documented in "Shi'er zhuhou nianbiao."

This study determined the first year of the Gonghe regency to be 850 B.C.E., now equated with Lord Zhen's fifteenth year. Lord Zhen died in his thirtieth year and was succeeded by Lord Wu in 834 B.C.E. Lord Wu ruled for ten years, thus placing Lord Yi's *yuan* in 824 B.C.E. Lord Yi ruled for nine years and was succeeded by Boyu in 815 B.C.E. Boyu ruled for eleven years, thus making Lord Xiao's *yuan* 804 B.C.E. King You perished in 780 B.C.E., which was indeed Lord Xiao's twenty-fifth year, as stated in "Lu Zhougong shijia."

Lord Yin's 隱公 *yuan* is fixed at 722 B.C.E. by the solar eclipse of 720 B.C.E. If the reign length of Lord Hui 惠公 is maintained at forty-six years, then Lord Hui's *yuan* remains in 768 B.C.E. and Lord Xiao reigned for thirty-six years (Table 8; see Table S12 for complete chronology).

113. *Shi ji*, 33.1848, 14.670.

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Table 8. Summary of Proposed Adjustments to the Chronology of Lu

	Shi ji				Adjusted				
B.C.E.	Zhou		Lu		Zhou		Lu		Remark
850					Li	21	Zhen	15	Gonghe regency starts
⋮	⋮		⋮		⋮		⋮		
841	Gonghe	1	Zhen	15	⋮		⋮		Start of chronology
⋮	⋮		⋮		⋮		⋮		
834	⋮		⋮		Xuan	3	Wu	1	
⋮	⋮		⋮		⋮		⋮		
825	Xuan	3	Wu	1	⋮		⋮		
824	⋮		⋮		Xuan	13	Yi	1	
⋮	⋮		⋮		⋮		⋮		
815	Xuan	13	Yi	1	Xuan	22	Boyu	1	
⋮	⋮		⋮		⋮		⋮		
806	Xuan	22	Boyu	1	⋮		⋮		Also Lord Xiao's *yuan*
⋮	⋮		⋮		⋮		⋮		
804	⋮		⋮		Xuan	33	Xiao	1	
⋮	⋮		⋮		⋮		⋮		
795	Xuan	42	Xiao	12	⋮		⋮		Lord Xiao's de facto *yuan*
⋮	⋮		⋮		⋮		⋮		
780	⋮		⋮		You	11	Xiao	25	King You is killed
⋮	⋮		⋮		⋮		⋮		
771	You	11	Xiao	36	⋮		⋮		Lord Xiao's de facto 25th year
⋮	⋮		⋮		⋮		⋮		
768	Ping	3	Hui	1	Ping	5	Hui	1	

Shi ji documents the reign lengths of all rulers of Lu with the sole exception of Boqin.[114] Based on this information, the *yuan* of Lord Zhen's predecessors (Lords Xian 獻公, Li 厲公, Wei 魏公, You 幽公, Yang 煬公, and Kao 考公) can all be derived (Table 9). The *yuan* of Lord Kao, Boqin's immediate successor, is 1007 B.C.E. This study has determined that Boqin was established as the first ruler of Lu in 1036 B.C.E. Assuming that his year count started the following year, Boqin ruled for twenty-eight years. The chronology of Lu is thus reconciled with the derived chronology of Western Zhou.

114. *Shi ji*, 33.1845.

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Table 9. The Derived *Yuan* of the Lords of Lu

Lord	*Yuan* (B.C.E.)	Reign (years)
Boqin 伯禽	1035	28
Kao 考公	1007	4
Yang 煬公	1003	6
You 幽公	997	14
Wei 魏公	983	50
Li 厲公	933	37
Xian 獻公	896	32
Zhen 真公	864	30
Wu 武公	834	10
Yi 懿公	824	9
Boyu 伯御	815	11
Xiao 孝公	804	36
Hui 惠公	768	46
Yin 隱公	722	11

THE CHRONOLOGY OF QI

According to "Qi Taigong shijia" 齊太公世家, the Gonghe regency started in the tenth year of Lord Wu's 武公 (of Qi) and Lord Yin of Lu was established in Lord Lí's 釐公 ninth year. Between Lords Wu and Lí there are Lords Lì 厲公, Wen 文公, Cheng 成公, and Zhuang 莊公. "Qi Taigong shijia" states that Lords Wu, Wen, Cheng, Zhuang, and Lí reigned for 26, 12, 9, 64, and 33 years, respectively, but curiously omits Lord Lì, who reigned for nine years according to "Shi'er zhuhou nianbiao."[115] This suggests that Sima Qian altered Lord Lì's reign length.

Therefore, the chronology of Qi is simply revised by maintaining the first year of the Gonghe regency (850 B.C.E.) as Lord Wu's tenth year, and Lord Yin of Lu's *yuan* (722 B.C.E.) as Lord Lí's ninth year, while preserving the reign lengths of Lords Wu, Wen, Cheng, Zhuang, and Lí (Table 10; see Table S12 for complete chronology). Lord Lì's reign is thus lengthened to eighteen years in the revised chronology of Qi, which is now reconciled with the derived chronology.

THE CHRONOLOGY OF WEI

According to "Wei Kangshu shijia," King Li fled the capital in Marquis Li's 釐侯 thirteenth year.[116] Both *Chun qiu* and *Zuo zhuan* record Lord

115. *Shi ji*, 14.650–88, 32.1795.
116. *Shi ji*, 37.1925.

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Table 10. Summary of Proposed Adjustments to the Chronology of Qi

	Shi ji				Adjusted				
B.C.E.	Zhou		Qi		Zhou		Qi		Remark
850					Li	21	Wu	10	Gonghe regency starts
⋮	⋮		⋮		⋮		⋮		
841	Gonghe	1	Wu	10	⋮		⋮		Start of chronology
⋮	⋮		⋮		⋮		⋮		
833	⋮		⋮		Xuan	4	Lì	1	
⋮	⋮		⋮		⋮		⋮		
824	Xuan	4	Lì	1	⋮		⋮		
⋮	⋮		⋮		⋮		⋮		
815	Xuan	13	Wen	1	Xuan	22	Wen	1	
⋮	⋮		⋮		⋮		⋮		
803	Xuan	25	Cheng	1	Xuan	34	Cheng	1	
⋮	⋮		⋮		⋮		⋮		
794	Xuan	34	Zhuang	1	Xuan	43	Zhuang	1	
⋮	⋮		⋮		⋮		⋮		
730	Ping	41	Lí	1	Ping	43	Lí	1	
⋮	⋮		⋮		⋮		⋮		
722	Ping	49	Lí	9	Ping	51	Lí	9	Lord Yin of Lu's *yuan*

Huan's 桓公 death in Lord Yin of Lu's fourth year,[117] thus fixing Lord Huan's final year in 719 B.C.E. Between Marquis Li and Lord Huan there are Lords Wu 武公 and Zhuang 莊公. According to "Wei Kangshu shijia," Marquis Li and Lords Wu, Zhuang, and Huan ruled for 42, 55, 23, and 16 years, respectively.[118] If the first year of the Gonghe regency is maintained as Marquis Li's fourteenth year, then then total years of these four rulers must be increased by nine. Since Marquis Li and Lord Wu ruled for 42 and 55 years, respectively, the extra nine years should be inserted in the reign of Lord Zhuang or Huan.

In "Wei Kangshu shijia," Lord Zhuang took as wife a lady from Qi in his fifth year. He later took as wife a lady from Chen 陳, whose younger sister bore Lord Zhuang a son—the future Lord Huan. Afterwards, Lord Zhuang's concubine gave birth to Lord Huan's younger brother Zhouxu 州吁. In Lord Zhuang's eighteenth year, Zhouxu had come of age (*zhang* 長) and showed an interest in military affairs. Lord Zhuang thus put Zhouxu in command of an army.[119]

117. *Chun qiu zuo zhuan zhengyi*, 3.95a, 99a (Yin 4).
118. *Shi ji*, 37.1925–26.
119. *Shi ji*, 37.1926.

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The transmitted tradition suggests that adulthood for men began at the age of twenty in pre-Qin times.[120] However, according to the narrative above, Zhouxu was less than thirteen years old in Lord Zhuang's eighteenth year. This inconsistency suggests that the extra nine years should be inserted in Lord Zhuang's reign.

To revise the chronology of Wei, the first year of the Gonghe regency (850 B.C.E.) is maintained as Marquis Li's fourteenth year, and the final year of Lord Huan is kept as Lord Yin of Lu's fourth year (719 B.C.E.), maintaining Lord Huan's *yuan* at 734 B.C.E. The reign lengths of Marquis Li as well as Lords Wu and Huan are preserved. This adjustment lengthens Lord Zhuang's reign to thirty-two years (Table 11; see Table S12 for complete chronology). Lord Zhuang's marriage to the lady of Qi is maintained in his fifth year (762 B.C.E.), and Zhouxu's coming of age remains six years before Lord Huan's *yuan*, now in Lord Zhuang's twenty-seventh year (740 B.C.E.). Zhouxu can thus be twenty years old when he comes of age, consistent with tradition.

THE CHRONOLOGY OF QIN

According to "Qin benji" 秦本紀, when King You was attacked by the Quan Rong 犬戎 in his final year, Lord Xiang 襄公 came to Zhou's aid. However, in "Shi'er zhuhou nianbiao," Lord Xiang's *yuan* is 777 B.C.E.,[121] which is three years after King You's death in the chronology derived in this study (780 B.C.E.). Lord Xiang's dates in *Shi ji* are thus clearly inaccurate.

"Qin Benji" states that Lord Ning's 寧公 fourth year was the final (eleventh) year of Lord Yin of Lu, thus fixing Lord Ning's *yuan* in 715 B.C.E. Lord Ning's predecessor was Lord Wen 文公, who succeeded Lord Xiang and ruled for fifty years. It is unlikely that Lord Wen's reign can be lengthened. Moreover, "Qin benji" states that Lord Xiang was the first ruler of Qin to be conferred a nobility title, in return for providing protection for King Ping's eastward move in 770 B.C.E.[122] Therefore, Lord Wen's *yuan* cannot predate 770 B.C.E., and is maintained at 765 B.C.E.

According to fragments of the original *Bamboo Annals* preserved in "Xi qiang zhuan" 西羌傳, Qinzhong 秦仲 was killed in King Xuan's fourth year, and Lord Xiang's elder brother was captured forty-five years later (in King You's third year) at Quanqiu 犬丘.[123] Based on the derived

120. *Li ji zhengyi*, 2.64a ("Qu li shang" 曲禮上).
121. *Shi ji*, 5.230, 14.669.
122. *Shi ji*, 5.230–32.
123. *Hou Han shu* 後漢書 (Beijing: Zhonghua, 1965), 87.2871–72.

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Table 11. Summary of Proposed Adjustments to the Chronology of Wei

	Shi ji				Adjusted				
B.C.E.	Zhou		Wei		Zhou		Wei		Remark
850					Li	21	Li	14	Gonghe Regency starts
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
841	Gonghe	1	Li	14	⋮	⋮	⋮	⋮	Start of chronology
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
821	⋮	⋮	⋮	⋮	Xuan	16	Wu	1	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
812	Xuan	16	Wu	1	⋮	⋮	⋮	⋮	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
766	⋮	⋮	⋮	⋮	Ping	7	Zhuang	1	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
762	⋮	⋮	⋮	⋮	Ping	11	Zhuang	5	Marriage to lady of Qi
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
757	Ping	14	Zhuang	1	⋮	⋮	⋮	⋮	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
753	Ping	18	Zhuang	5	⋮	⋮	⋮	⋮	Marriage to lady of Qi
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
740	Ping	31	Zhuang	18	Ping	33	Zhuang	27	Zhouxu comes of age
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
734	Ping	37	Huan	1	Ping	39	Huan	1	

chronology, Qinzhong died in 833 B.C.E. and Lord Xiang's brother was captured in 788 B.C.E.

Shi ji states that Lord Xiang's brother was captured in Lord Xiang's second year. If Lord Xiang's *yuan* is in 789 B.C.E., then Qinzhong's successor, Lord Zhuang 莊公, reigned for forty-three years (832–790 B.C.E.) before being succeeded by Lord Xiang. However, Lord Zhuang ruled for forty-four years according to *Shi ji*.[124]

This one-year discrepancy can be explained by differences in the calendar used by the texts. According to Du Yu 杜預, the *Bamboo Annals* used the Xia calendar, which starts the calendar year in the month of *yin* 寅 (containing the solar term *yushui* 雨水).[125] On the other hand, "Qin benji" preserves primary sources from Qin, and presumably follows the Qin calendar, which begins the calendar year with the month of *hai* (containing the solar term *xiaoxue* 小雪).[126] The Qin calendar year thus starts

124. *Shi ji*, 5.229.
125. See Du Yu's afterword in *Chun qiu zuo zhuan zhengyi*, 1982a–b ("Hou xu" 後序).
126. Zhang Peiyu et al., *Zhongguo gudai lifa*, 245.

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three months earlier than the Xia calendar year. Therefore, Lord Xiang's brother may have been captured near the end of the year in the Xia calendar, which was already in the next year in the Qin calendar, resulting in a one-year difference.

Lord Zhuang's reign length of forty-four years is thus preserved in the revised chronology, placing Lord Xiang's *yuan* in 788 B.C.E. Since Lord Wen's *yuan* is maintained at 765 B.C.E., Lord Xiang's reign is lengthened to twenty-three years. The reign lengths of Lord Zhuang's predecessors recorded in "Qin benji" are also assumed to be accurate and preserved in the revised chronology, thus completing the revision process (Table 12; see Table S12 for complete chronology).

THE CHRONOLOGY OF JIN

Xinian, *Guo yu*, and "Zhou benji" all state that King Xuan was defeated at the Battle of Qianmu 千畝之戰 in his thirty-ninth year. However, "Jin shijia" 晉世家 states that this battle occurred in Marquis Mu's 穆侯 tenth year, which "Shi'er zhuhou nianbiao" places in King Xuan's twenty-sixth year.[127] This discrepancy shows that the chronology of Jin in *Shi ji* is significantly distorted.

Xinian states that King Hui of Xie was killed in his twenty-first year.[128] The *Bamboo Annals* also states that Marquis Wen of Jin 晉文侯 killed the Xie King 攜王 in the twenty-first year,[129] but does not indicate whose calendar the "twenty-first year" belongs to. Du Yu suggests that the focus of the *Bamboo Annals* shifted to the Jin state following King You's death.[130] According to *Xinian*, Marquis Wen was an early supporter of King Ping. As a text documenting history from the perspective of Jin, the *Bamboo Annals* was thus unlikely to use the Xie King's regnal years. Therefore, the twenty-first year in the *Bamboo Annals* can only belong to Marquis Wen's calendar, placing Marquis Wen's *yuan* in the same year as King Hui of Xie's *yuan* (779 B.C.E.), only one year after Marquis Wen's *yuan* given in *Shi ji* (780 B.C.E.).

According to Du Yu, throughout Xia, Shang, and (Western) Zhou, the *Bamboo Annals* only recorded events pertaining to the kings. Events in the *Bamboo Annals* unrelated to the kings all pertain to Jin, or Wei 魏 after Jin's dissolution. The events pertaining to Jin begin with events of Shangshu 殤叔, followed by those of Marquises Wen and Zhao 昭侯, followed by the events of Quwo Zhuangbo 曲沃莊伯 (see n. 125). Presum-

127. Li Xueqin, ed., *Qinghua daxue cang Zhanguo zhujian (er)*, 136; *Guo yu jijie*, ed. Xu Yuangao, 21; *Shi ji*, 4.183, 39.1979, 14.663.

128. Li Xueqin, ed., *Qinghua daxue cang Zhanguo zhujian (er)*, 138.

129. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 71.

130. See Du Yu's afterword in *Chun qiu zuo zhuan zhengyi*, 1982a–83a ("Hou xu" 後序).

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Table 12. Summary of Proposed Adjustments to the Chronology of Qin

	Shi ji				Adjusted				
B.C.E.	Zhou		Qin		Zhou		Qin		Remark
855					Li	16	Qinzhong	1	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
841	Gonghe	1	Qinzhong	14	⋮	⋮	⋮	⋮	Start of chronology
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
833	⋮	⋮	⋮	⋮	Xuan	4	Qinzhong	23	Qinzhong is killed
832	⋮	⋮	⋮	⋮	Xuan	5	Zhuang	1	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
821	Xuan	7	Zhuang	1	⋮	⋮	⋮	⋮	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
788	⋮	⋮	⋮	⋮	You	3	Xiang	1	Siege of Quanqiu
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
777	You	5	Xiang	1	⋮	⋮	⋮	⋮	
776	You	6	Xiang	2	⋮	⋮	⋮	⋮	Siege of Quanqiu
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
770	Ping	1	Xiang	8	Ping	3	Xiang	19	King Ping moves east
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
765	Ping	6	Wen	1	Ping	8	Wen	1	

ably, the focus of the *Bamboo Annals* shifted from the Zhou kings to the Jin marquises following the death of King You, implying that Shangshu reigned past King You's eleventh year.

However, if Marquis Wen's *yuan* is in the same year as King Hui of Xie's *yuan*, then Shangshu's final year is also the same year as King You's final year, suggesting that Shangshu did not reign past King You's eleventh year. This apparent conflict may reflect the difference between the Zhou and Xia calendars. The Zhou calendar year begins with the month of *zi*, whereas the Xia calendar year starts two months later in the month of *yin*. Therefore, if King You died early in his eleventh year, then it would have been before the start of Shangshu's final year, allowing Shangshu to reign past King You's death.

"Jin shijia" states that King Xuan died in Shangshu's third year,[131] suggesting that Sima Qian saw source material from Jin that documented the death of a king in Shangshu's third year. From the analysis above, this king must be King You. Shangshu's final year was thus his fourth year, in agreement with the length of Shangshu's reign given in "Jin shijia" (see n. 131). Shangshu's *yuan* is thus 783 B.C.E.

131. *Shi ji*, 37.1980.

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The inscription of Jin Hou Su *zhong* documents events spanning King Xuan's thirty-third and thirty-fourth year (804 and 803 B.C.E.). There is broad consensus identifying Jin Hou Su with Marquis Xian 獻侯,[132] based on the text of *Shiben* 世本 quoted in the *Suoyin* 索隱 commentary to *Shi ji*.[133] Since Shangshu's *yuan* is 783 B.C.E., the *yuan* of Marquis Mu 穆侯, Shangshu's predecessor and Jin Hou Su's successor, must be between 802 and 784 B.C.E. (inclusive).

Which year between 802 and 784 B.C.E. is Marquis Mu's *yuan*? Of all the material accessible to Sima Qian, the chronological data of Lu were the most extensive. Sima Qian likely used the chronology of Lu as a reference frame to assemble "Shi'er zhuhou nianbiao." Therefore, the correspondence between the regnal years of Jin and Lu may offer important clues for revising the chronology of Jin. In "Shi'er zhuhou nianbiao," Marquis Mu's *yuan* is Lord Yi of Lu's fifth year (811 B.C.E.). This suggests that Sima Qian may have seen material that placed Marquis Mu's *yuan* in the fifth year of a certain lord of Lu. According to the revised chronology of Lu, 802 and 784 B.C.E. correspond to Lord Xiao of Lu's third and twenty-first year, respectively. Therefore, Marquis Mu's *yuan* is set to Lord Xiao of Lu's fifth year: 800 B.C.E.

The first year of the Gonghe regency (850 B.C.E.) is maintained as Marquis Jing's 靖侯 eighteenth year, and the reign lengths of Marquises Jing and Li 釐侯 are kept at eighteen years each. Consequently, the *yuan* of Marquises Jing, Li, and Xian are 867, 849, and 831 B.C.E., respectively. Marquis Xian's reign is lengthened from eleven to thirty-one years, whereas Marquis Mu's reign is shortened from twenty-seven to seventeen years. Marquis Xiao's 孝侯 *yuan* is maintained as Lord Hui of Lu's thirtieth year (739 B.C.E.), as documented in *Zuo zhuan*.[134] The reign length of Marquis Zhao (Marquis Xiao's predecessor) is kept at six years, maintaining his *yuan* at 745 B.C.E. (Table 13; see Table S12 for complete chronology).

THE CHRONOLOGY OF ZHENG

Shuijing zhu 水經注 cites the *Bamboo Annals* stating that Lord Huan of Zheng 鄭桓公 defeated Kuai 鄶 in Marquis Wen of Jin's second year. Fang Shiming and Wang Xiuling also noted that the commentary to *Han shu* quotes Zan 瓚 stating that Lord Huan defeated Kuai two years after King You's demise. Zan is believed to have taken part in editing the original excavated slips of the *Bamboo Annals*, thus his statement was likely

132. Shim, "The 'Jinhou Su *Bianzhong*' Inscription and Its Significance."

133. *Shi ji*, 37.1979n1. *Shiben* was referred to as *Xiben* 系本 in the Tang dynasty to avoid using the character *shi* 世 from Emperor Taizong's 太宗 name (Li Shimin 李世民).

134. *Chun qiu zuo zhuan zhengyi*, 5.178b (Huan 2).

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Table 13. Summary of Proposed Adjustments to the Chronology of Jin

	Shi ji				Adjusted				
B.C.E.	Zhou		Jin		Zhou		Jin		Remark
850					Li	21	Jing	18	Gonghe regency starts
849					Li	22	Li	1	
⋮					⋮		⋮		
841	Gonghe	1	Jing	18	⋮		⋮		Start of chronology
840	Gonghe	2	Li	1	⋮		⋮		
⋮	⋮		⋮		⋮		⋮		
831	⋮		⋮		Xuan	6	Xian	1	
⋮	⋮		⋮		⋮		⋮		
822	Xuan	6	Xian	1	⋮		⋮		
⋮	⋮		⋮		⋮		⋮		
811	Xuan	17	Mu	1	⋮		⋮		Lord Yi of Lu's 5th yr.
⋮	⋮		⋮		⋮		⋮		
802	Xuan	26	Mu	10	⋮		⋮		Battle of Qianmu
⋮	⋮		⋮		⋮		⋮		
800	⋮		⋮		Xuan	37	Mu	1	Ld. Xiao of Lu's 5th yr.
⋮	⋮		⋮		⋮		⋮		
798	⋮		⋮		Xuan	39	Mu	3	Battle of Qianmu
⋮	⋮		⋮		⋮		⋮		
784	Xuan	44	Shangshu	1	⋮		⋮		
783	⋮		⋮		You	8	Shangshu	1	
⋮	⋮		⋮		⋮		⋮		
780	You	2	Wen	1	⋮		⋮		
779	⋮		⋮		No king		Wen	1	King Hui of Xie's *yuan*
⋮	⋮		⋮		⋮		⋮		
759	⋮		⋮		Ping	14	Wen	21	King Hui of Xie killed
⋮	⋮		⋮		⋮		⋮		
745	Ping	26	Zhao	1	Ping	28	Zhao	1	
⋮	⋮		⋮		⋮		⋮		
739	Ping	32	Xiao	1	Ping	34	Xiao	1	Ld. Hui of Lu's 30th yr.

based on the *Bamboo Annals* as well.[135] However, in "Shi'er zhuhou nianbiao," Marquis Wen's second year is King You's third year. Therefore, Zan's statement apparently conflicts with the *Bamboo Annals* as quoted in *Shuijing zhu*. Moreover, "Zheng shijia" 鄭世家 states that Lord Huan

135. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 70–71.

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perished alongside King You,[136] which is incompatible with both the quotation from *Shuijing zhu* and Zan's statement.

However, in the revised chronology of Jin, Marquis Wen's second year is indeed two years after King You's death (Table S12), showing that Zan's statement and the quotation from *Shuijing zhu* are in fact compatible with each other. This result justifies the proposed revisions to the chronology of Jin, and further bolsters the reliability of the *Bamboo Annals*. The statement in "Zheng shijia" that Lord Huan perished alongside King You is rejected as inaccurate.

To revise the chronology of Zheng, Lord Huan's *yuan* is simply maintained at King Xuan's twenty-second year (815 B.C.E.), while the *yuan* of Lords Wu 武公 and Zhuang 莊公 are maintained at 770 and 743 B.C.E., respectively (Table 14; see Table S12 for complete chronology). Lord Huan's reign is lengthened to forty-five years.

The chronologies of Lu, Qi, Wei, Qin, Jin, and Zheng have now all been reconciled with the chronology of Zhou derived in this study.

The Eclipse of *Shi Jing*

The first stanza of "Shiyue zhi jiao" 十月之交 (Mao 193) describes a solar eclipse that occurred on *xinmao* 辛卯 (28) of the tenth month:[137]

> At the sun-moon conjunction in the tenth month (十月之交),
>
> The day of the new moon was *xinmao* (朔月辛卯).
>
> The sun was eclipsed (日有食之),
>
> Which was a very evil omen (亦孔之醜).

Mao's commentary believes this poem describes events in King You's reign, whereas Zheng's notes place the poem in King Li's reign. According to Kong Yingda 孔穎達, the earliest known attempt to date this eclipse was made by Wang Ji 王基. However, Wang Ji was ultimately unsuccessful, presumably due to the limited accuracy of the calendar used.[138] The Tang dynasty astronomer Yixing 一行 states that Yu Kuo 虞劇 of the Southern Liang dynasty first dated the eclipse to King You's sixth year,[139] which is 776 B.C.E. according to *Shi ji*. This result was later corroborated by the French Jesuit Antoine Gaubil using

136. *Shi ji*, 42.2121–23.
137. *Mao shi zhengyi*, 12.842a ("Shiyue zhi jiao" 十月之交).
138. *Mao shi zhengyi*, 12.845a ("Shiyue zhi jiao").
139. *Xin Tang shu* 新唐書 (Beijing: Zhonghua, 1975), 27.625 ("Rishi yi" 日蝕議).

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Table 14. Summary of Proposed Adjustments to the Chronology of Zheng

	Shi ji				Adjusted				
B.C.E.	Zhou		Zheng		Zhou		Zheng		Remark
815	⋮				Xuan	22	Huan	1	
⋮	⋮				⋮		⋮		
806	Xuan	22	Huan	1	⋮		⋮		
⋮	⋮		⋮		⋮		⋮		
780	⋮		⋮		You	11	Huan	36	King You is killed
779	⋮		⋮		No king		Huan	37	Marquis Wen of Jin's *yuan*
778	⋮		⋮		No king		Huan	38	Lord Huan defeats Kuai
⋮	⋮		⋮		⋮		⋮		
770	Ping	1	Wu	1	Ping	3	Wu	1	King Ping moves east
⋮	⋮		⋮		⋮		⋮		
743	Ping	28	Zhuang	1	Ping	30	Zhuang	1	

more sophisticated astronomical calculations.[140] The solar eclipse that year (JDN 1438238) occurred on *xinmao* (28) of the tenth month in the Zhou calendar.

Song dynasty scholars began doubting Yu Kuo's result based on the belief that *Shi jing* used the Xia calendar, which starts the year in the month of *yin*.[141] The Reverend Samuel Johnson later showed that the eclipse of 776 B.C.E. was not visible in the Western Zhou capital.[142] This eclipse thus cannot be the one described by the poem.

Besides the eclipse of 776 B.C.E., there are only four solar eclipses on the *xinmao* day observable from China between the ninth and seventh centuries B.C.E., in the years 781, 735, 729, and 636 B.C.E.[143] If "Shiyue zhi jiao" documents a real observation, it must be one of these four.

If the eclipse of "Shiyue zhi jiao" occurred in late Western or early Eastern Zhou, it could not have been in 636 B.C.E. Johnson proposed that the eclipse occurred on June 4, 781 B.C.E. (JDN 1436318, see n.

140. Antoine Gaubil, *Histoire de l'Astronomie Chinoise, Observations Mathématiques, Astronomiques, Géographiques, Chronologiques, et Physiques*, vol. 2 (Paris: Chez Rollin, 1732), 151–55.

141. Lü Zuqian 呂祖謙, *Lüshi jiashu dushi ji* 呂氏家塾讀詩記, *Yingyin wenyuange siku quanshu* 景印文淵閣四庫全書, vol. 73 (Taipei: Taiwan Shangwu, 1986), 20.580b.

142. Samuel J. Johnson, *Historical and Future Eclipses, with Notes on Planets, Double Stars, and Other Celestial Matters* (London: James Parker, 1896), 8.

143. Liu Ciyuan 劉次沅 and Zhou Xiaolu 周曉陸, "*Shi jing* rishi jiqi tianwen huanjing" 詩經日食及其天文環境, *Shaanxi tianwentai taikan* 陝西天文台台刊 25 (2002), 74–80.

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142), whereas Hirayama Kiyotugu 平山清次 and Ogura Sinkiti 小倉伸吉 argued that the eclipse occurred on November 30, 735 B.C.E. (JDN 1453298).[144]

The second stanza of "Shiyue zhi jiao" includes key information to identify the eclipse:[145]

> The sun and moon announce evil (日月告凶),
>
> Not keeping to their proper paths (不用其行).
>
> Governance is absent throughout the realm (四國無政).
>
> The good are not employed (不用其良).
>
> For the moon to be eclipsed (彼月而食),
>
> Is but an ordinary matter (則維其常).
>
> Now that the sun has been eclipsed (此日而食),
>
> How awful it is (于何不臧)!

According to the text, lunar eclipses were viewed as an ordinary matter, whereas the solar eclipse was seen as an evil omen, suggesting that multiple lunar eclipses had been observed before the solar eclipse. Within the two years immediately preceding the solar eclipse, there were two total and two partial lunar eclipses before the eclipse of 729 B.C.E., three total lunar eclipses before the eclipse of 735 B.C.E., as well as two total and one partial lunar eclipses before the eclipse of 781 B.C.E.[146] The number of lunar eclipses before each candidate eclipse is thus similar.

The second stanza implies that the solar eclipse was a rare event compared to the lunar eclipse, a point largely overlooked by previous analyses. Here, the amount of time between each candidate eclipse and its last preceding observable eclipse is examined. Observable eclipses are defined as solar eclipses with a magnitude of at least 0.26, the minimum magnitude of all confirmed solar eclipses in *Chun qiu*.[147]

The eclipses of 729 and 735 B.C.E. are each preceded by an observable eclipse in the previous year, in 730 and 736 B.C.E., respectively. In contrast, the eclipse of 781 B.C.E. is eight years after the last observable

144. Kiyotugu Hirayama and Sinkiti Ogura, "On the Eclipses Recorded in the Shu Ching and Shih Ching," *Proceedings of the Tokyo Mathematico-Physical Society*. 2nd Ser. 8.1 (1915), 2–8.

145. *Mao shi zhengyi*, 12.845b–46a ("Shiyue zhi jiao").

146. Lunar eclipses were calculated using NASA's JavaScript Lunar Eclipse Explorer for Asia and Asian Minor (https://eclipse.gsfc.nasa.gov/JLEX/JLEX-AS.html). The coordinates of Xi'an were provided by NASA, the coordinates 34° 37' 12.72" N, 112° 27' 14.04" E were used for Luoyang.

147. Zhang Peiyu et al., *Zhongguo gudai lifa*, 166–71.

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eclipse in 789 B.C.E.[148] Since the poem uses the solar eclipse as a metaphor for bad governance, if two eclipses had occurred in consecutive years, the poem surely would have mentioned them as evidence of Heaven's disapproval. However, the poem makes no such mention. Therefore, the eclipses of 729 and 735 B.C.E. can be excluded.

The eclipse of 781 B.C.E. is in the seventh month of the Zhou calendar year (fifth month of the Xia calendar year), whereas the text states that the eclipse occurred in the tenth month. Pang Sunjoo views this contradiction as evidence of textual corruption. He notes that the character "ten" is highly similar to the archaic glyph for "seven" (十), and proposes that the original poem documented an eclipse in the seventh month (see n. 69). There are concrete examples of errors caused by confusing "seven" and "ten." The "seventh month" in the inscription date of Bo Ke *hu* was erroneously transcribed as the "tenth month" in *Bogu tu* 博古圖,[149] whereas *Chun qiu* documents an eclipse in the seventh month of Lord Xuan's 宣公 eighth year (601 B.C.E.) that actually occurred in the tenth month of that year (JDN 1502171).[150]

Therefore, this study combines the proposals of Johnson and Pang Sunjoo, and identifies the eclipse of *Shi jing* as the solar eclipse of 781 B.C.E. (JDN 1436318), which occurred on *xinmao* of the seventh month of King You's tenth year (calendar year 370).

The *Bamboo Annals*

UTILITY FOR CHRONOLOGICAL STUDIES

As this study demonstrates, the Ancient Text *Bamboo Annals* is fully compatible with bronze inscription dates. Moreover, in the process of derivation, apparent inconsistencies were all successfully resolved. Although these results cannot rigorously prove the reliability or authenticity of the Ancient Text *Bamboo Annals*, they nonetheless highlight the exceptional value of this text for chronological studies.

As even the proponents of the authenticity of the Modern Text *Bamboo Annals* acknowledge, the chronology contained in the Modern Text *Bamboo Annals* is inaccurate.[151] The absolute dates of Kings Xuan and You given in the text are identical to those given in *Shi ji*, which means that the Modern Text *Bamboo Annals* also contradicts the inscription dates of

148. Solar eclipses were calculated using NASA's JavaScript Solar Eclipse Explorer for Asia and Asia Minor (https://eclipse.gsfc.nasa.gov/JSEX/JSEX-AS.html). The coordinates of Xi'an were provided by NASA, the coordinates of Luoyang are given in n. 146.

149. Wang Fu 王黼, *Bogu tu* (Beijing: Yizheng tang, 1753), 6.33b.

150. Zhang Peiyu et al., *Zhongguo gudai lifa*, 170.

151. Pankenier, "Astronomical Dates in Shang and Western Zhou"; Nivison, "The Dates of Western Chou"; Shaughnessy, "On the Authenticity of the *Bamboo Annals*."

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Lai *ding* (see n. 23). In addition, the Modern Text *Bamboo Annals* states that King Gong reigned for only twelve years, clearly contradicting the inscription of the fifteenth year Que Cao *ding*.[152] Moreover, the Modern Text *Bamboo Annals* documents a solar eclipse on the *xinmao* day of the tenth month of King You's sixth year,[153] which is a clear reference to the solar eclipse of 776 B.C.E. Modern calculations show that this eclipse is invisible from Xi'an (see n. 142), therefore this entry in the Modern Text *Bamboo Annals* can only reflect calculations done by a later author, presumably based on the poem "Shiyue zhi jiao." This entry must postdate Wang Ji of the Three Kingdoms period (220–280 C.E.), and likely postdates Yu Kuo of the Southern Liang dynasty (502–557 C.E.). Furthermore, this study shows that 776 B.C.E. is not even King You's sixth year.

It thus becomes apparent that the author or editor who produced the Modern Text *Bamboo Annals* was ignorant of the true dates of Western Zhou. The simplest explanation is that the Modern Text *Bamboo Annals* is a forgery, although the possibility that it contains authentic but distorted information cannot be strictly excluded. However, this possibility cannot be investigated in a reliable way without concrete knowledge of the true dates of Western Zhou. Therefore, the Modern Text *Bamboo Annals* cannot be used for chronological reconstruction.

THE ACCURACY OF INDIRECT QUOTES

The Ancient Text *Bamboo Annals* contains indirect quotes which must be treated with caution. It has long been assumed that the *Bamboo Annals* gave the total duration of Western Zhou as 257 years (see n. 86). However, this study shows that statements in the *Bamboo Annals* related to the total years of Western Zhou are indirect quotes that most likely misrepresent the original text. The 257 years should be counted from Zhou's initial expedition against Shang to King You's *yuan* (inclusive), whereas Western Zhou totaled 265 years (1044–780 B.C.E.).

The *Bamboo Annals* also contains a statement related to the total years of Xia: "From Yu to Jie there were seventeen generations, with and without kings, taking up 471 years" (自禹至桀十七世, 有王與無王, 用歲四百七十一年). Another statement is related to the total years of Shang: "From Tang's extermination of Xia to Shou (i.e. Zhòu), there were twenty-nine kings, taking up 496 years" (湯滅夏以至于受, 二十九王, 用歲四百九十六年). Other statements in the *Bamboo Annals* simply describe the 471 and 496 years as the total years of Xia and Shang, respectively,[154] which is inconsistent with the *Bamboo Annals* also stating that Xia lasted

152. Wang Guowei, *Jinben Zhushu jinian shuzheng*, 269–82.
153. Wang Guowei, *Jinben Zhushu jinian shuzheng*, 282.
154. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 20, 40–41.

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longer than Shang.[155] This inconsistency can be resolved by counting the 471 and 496 years to the *yuan* of Jie and Zhòu, respectively: If Jie's reign was at least 25 years longer than Zhòu's reign, then the Xia dynasty would be longer than the Shang dynasty.

Therefore, in the *Bamboo Annals*, the number of years "from time point A to King B" is always counted to King B's *yuan*. Notably, the *Bamboo Annals* also counts the number of years "from Pan Geng's relocation to Yin, to Zhòu's demise" (自盤庚遷殷, 至紂之滅).[156] Although the text is unambiguous about the ending point of the year count, whether it accurately reflects the original text is unclear—considering other similar statements, the year count likely ends in Zhòu's *yuan*.

Guo Yu

The "Zhou yu xia" 周語下 chapter of *Guo yu* records Ling Zhou Jiu's 伶州鳩 account describing the positions of a number of celestial bodies during King Wu's conquest of Shang:[157]

> Previously (when) King Wu campaigned against the Shang (昔武王伐殷),
>
> Jupiter was in the Chunhuo Station (歲在鶉火),
>
> The moon was in the Tiansi constellation (i.e. Fang 房 Mansion) (月在天駟),
>
> The sun was in the ford (i.e. Milky Way) of the Ximu Station (日在析木之津),
>
> The new moon was at the handle of the (Southern) Dipper (辰在斗柄),
>
> (and) Mercury was in the Tianyuan (i.e. Xuanxiao 玄枵) Station (星在天黿).

Starting from Liu Xin, many scholars have used this text as a primary source in their attempts to derive the year of the conquest. This approach makes the fundamental assumption that the positions of the celestial bodies are accurately described. However, whereas it is possible to directly observe the positions of Jupiter, Mercury, and the moon, the positions of the sun and the new moon can only be derived from computation.[158] If the positions were derived from computation, they are likely to be inaccurate due to the limitations of the underlying cal-

155. *Jin shu* 晉書 (Beijing: Zhonghua, 1974), 51.1432.
156. Fang Shiming and Wang Xiuling, *Guben Zhushu jinian jizheng*, 31–32.
157. *Guo yu jijie*, ed. Xu Yuangao, 123–24 ("Zhou yu xia").
158. Zhang Peiyu, "Shilun '*Guo yu*' '*Zuo zhuan*' tianxiang jishi de shiliao jiazhi" 試論《國語》《左傳》天象紀事的史料價值, *Shixue yuekan* 史學月刊 2009.1, 68–78.

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endar. Moreover, even if the calendar has enough accuracy, *Guo yu* will not give the true positions of the celestial bodies during King Wu's campaign if the author did not know the true dates of the conquest.

Ling Zhou Jiu gives the position of Jupiter in reference to the Jupiter calendar, which assumes that Jupiter completes a cycle against the background of stars in exactly twelve years. The ecliptic was divided into twelve stations (*xingci* 星次) so that Jupiter occupied one station per year, and each year in the Jupiter calendar was named after the station hosting Jupiter.

Besides Ling Zhou Jiu's account, *Guo yu* contains additional records of Jupiter's position, all in the chapter "Jin yu si" 晉語四.[159] *Zuo zhuan* also describes Jupiter's position many times.[160] Unlike the year of the conquest, the absolute dates of these additional mentions of Jupiter's position are known—all are in the Spring and Autumn period—and fit in the same Jupiter calendar (see n. 158). However, Shinjō showed that none of the verifiable mentions of the Jupiter stations in *Guo yu* and *Zuo zhuan* are the true positions of Jupiter. These records of Jupiter's position thus cannot be contemporary observations, but must have been derived by a later author based on a calendar with insufficient accuracy. Assuming that the Jupiter calendar in *Guo yu* and *Zuo zhuan* originally matched the true positions of Jupiter, Shinjō estimated that the calendar started around 376 B.C.E.[161] *Guo yu* and *Zuo zhuan* thus cannot predate the middle stage of the Warring States period.

Given the significant errors of the Jupiter calendar in the Spring and Autumn period, one cannot expect Ling Zhou Jiu's description of Jupiter's position centuries earlier during King Wu's campaign to be accurate, even if the author of *Guo yu* knew the accurate dates of the conquest. Therefore, the position of Jupiter in Ling Zhou Jiu's account cannot serve as a reliable basis to derive the year of the conquest.

Indeed, the year of the conquest (1044 B.C.E.) derived in this study is the year of Shishen 實沈 in the Jupiter calendar, and the initial expedition (1046 B.C.E.) is in the year of Jianglou 降婁. Ling Zhou Jiu's account is therefore incompatible with this study.

Texts Related to King Wu

Derivation of a complete chronology of Western Zhou relied on a number of texts including the *Bamboo Annals*, *Xinian*, and relevant chapters

159. *Guo yu jijie*, ed. Xu Yuangao, 321–23, 324–25, 343–44 ("Jin yu si").

160. *Chun qiu zuo zhuan zhengyi*, 38.1230a–32a, 40.1286b–87a, 44.1454a, 45.1463a–65a, 45.1469a–70b, 45.1478a–b, 53.1754b.

161. Shinjō, *Dongyang tianwenxueshi yanjiu*, trans. Shen Xuan, 384–92.

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of *Shang shu* and *Yizhoushu*. This result demonstrates that these texts are compatible with bronze inscriptions, although it cannot rigorously prove the authenticity or reliability of these texts. Here, a selection of additional pre-Qin texts related to King Wu or the Zhou conquest of Shang are examined for their compatibility with the derived chronology. Although this approach cannot establish their authenticity or reliability, it nonetheless provides valuable insight. This study concludes that King Wu continued King Wen's year count and led an initial expedition against the Shang in the eleventh year, as well as a second expedition in the thirteenth year which achieved final victory. King Wu then died the next (fourteenth) year.

Other chapters of *Shang shu* are consistent with this result. "Hong fan" 洪範 states that King Wu spoke with Jizi 箕子 in the thirteenth year, after Shang's defeat. "Jin teng" 金縢 states that King Wu fell ill in "*ji ke Shang ernian*" 既克商二年,[162] which must be interpreted here as "the year after defeating Shang," rather than "two years after defeating Shang." Additional chapters from *Yizhoushu* also agree with the derived chronology. Both "Da kuang" 大匡 and "Wen zheng" 文政 document events in the thirteenth year following Shang's defeat, whereas "Zuo luo" 作雒 states that King Wu died the year after defeating Shang.[163]

However, many other chapters of *Yizhoushu* contradict the derived chronology. "Rou wu" 柔武 cites King Wu's *yuan* (元祀), "Da kai wu" 大開武 cites his first year (一祀), "Xiao kai wu" 小開武 cites his second year, and "Bao dian" 寶典 as well as "Feng mou" 酆謀 cite his third year.[164] All are inconsistent with King Wu continuing King Wen's year count. "Bao dian" and "Wu jing" 寤儆 contain dates that use the lunar phase *shuo*,[165] which cannot be genuine Western Zhou calendar dates. In addition, "Ming tang" 明堂 states that King Wu died five or six years after defeating Zhòu (*ji ke Zhou liunian* 既克紂六年),[166] contradicting "Zuo luo."

Lüshi chunqiu 呂氏春秋 explicitly states that King Wu defeated the Shang in his twelfth year as king.[167] "Qi ye" 耆夜 from the Tsinghua bamboo slips implies that King Wu established his own *yuan* and ruled for at least eight years. An alternative version of "Jin teng," also from the Tsinghua bamboo slips, describes events two or three years after defeat-

162. *Shang shu zhengyi*, 12.352a, 13.393b.
163. *Yizhoushu huijiao jizhu*, ed. Huang Huaixin et al., 4.361, 4.373, 5.514.
164. *Yizhoushu huijiao jizhu*, ed. Huang Huaixin et al., 3.251, 258, 272, 279, 296.
165. *Yizhoushu huijiao jizhu*, ed. Huang Huaixin et al., 3.279, 303.
166. *Yizhoushu huijiao jizhu*, ed. Huang Huaixin et al., 6.710 ("Ming tang" 明堂).
167. *Lüshi chunqiu jishi* 呂氏春秋集釋, ed. Xu Weiyu 許維遹 (Beijing: Zhonghua, 2009), 322 ("Shou shi" 首時 14.3).

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ing the Shang (*ji ke Shang sannian* 既克商三年).[168] All are incompatible with the derived chronology as well.[169]

Lüshi chunqiu was compiled shortly before the end of the Warring States, whereas radiocarbon dating places the Tsinghua bamboo slips in the middle to late stages of the Warring Sates, between 355 and 255 B.C.E.[170] The dates of the individual chapters of *Shang shu* and *Yizhoushu* are much less certain. "Zuo luo" is among seven chapters (including "Shi fu") believed to preserve genuine information from Western Zhou, whereas the other chapters of *Yizhoushu* mentioned above are believed to be texts from the Spring and Autumn or Warring States period.[171] "Hong fan" and "Jin teng" are similarly dated to Eastern Zhou.[172] Notably, all texts incompatible with the derived chronology are from later dates, whereas the older "Zuo luo" chapter is compatible with the derived chronology.

Discussion and Conclusion

Comparison with Previous Reconstructions

A detailed discussion of the pros and cons of all previous work is well beyond the scope of this study. Instead, the discussion here will focus on two influential reconstructed chronologies (Table 15).

THE ASSUMPTIONS

The chronology derived in this study differs significantly from the chronologies proposed by Shaughnessy and the Chronology Project, primarily due to differences in interpreting the specialized terms. The Chronology Project assumes that *chuji* refers to the first ten days of the month and appears to interpret the remaining three terms similar to hypothesis B (see Table 1), without clearly specifying the boundary between *jiwang* and *jisiba*.[173] Meanwhile, Shaughnessy adheres to Wang

168. Li Xueqin, ed., *Qinghua daxue cang Zhangguo zhujian (yi)* 清華大學藏戰國竹簡（壹）(Shanghai: Zhongxi, 2010), 150, 158.

169. Du Yong 杜勇 already raised questions about the reliability of "Qi ye" based on textual analysis, see Du Yong, "Cong Qinghuajian 'Qi ye' kan gushu de xingcheng" 從清華簡《耆夜》看古書的形成, *Zhongyuan wenhua yanjiu* 中原文化研究 2013.6, 18–27.

170. Liu Guozhong, *Zoujin Qinghuajian* 走近清華簡 (Beijing: Gaodeng jiaoyu, 2011), 47–48.

171. Liu Qiyu 劉起釪, *Shang shu xueshi* 尚書學史 (Beijing: Zhonghua, 1989), 93–97.

172. Gu Jiegang, "Lun 'Jinwen *Shang shu*' zhuzuo shidai shu" 論《今文尚書》著作時代書, in *Gushi bian* 古史辨, ed. Gu Jiegang, Luo Genze 羅根澤, Lü Simian 呂思勉, and Tong Shuye 童書業, vol. 1 (Shanghai: Shanghai guji, 1982), 200–206.

173. Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 35–36.

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Table 15. Comparing Proposed Chronologies

	This Study		Shaughnessy		Chronology Project	
Reign	*Yuan* (B.C.E.)	Length (years)	*Yuan* (B.C.E.)	Length (years)	*Yuan* (B.C.E.)	Length (years)
Wen	1056	N.D.	1099/56	50/7	N.D.	N.D.
Wu	None		1049/45	7/3	1046	4
Duke of Zhou	None		1042	7	None	
Cheng	1042	32	1042/35	37/30	1042	22
Kang	1010	19	1005/3	28/26	1020	25
Zhao	991	34	977/75	21/19	995	19
Mu	957	40	956	39	976	55
Gong	917	18	917/15	18/16	922	23
Yih	899	12	899/97	27/25	899	8
Xiao	887	6	872	7	891	6
Yi	881	11	865	8	885	8
Li	870	34	857/53	16/12	877	37
Gonghe	None		841	14	841	14
Xuan	836	46	827/25	46/44	827	46
You	790	11	781	(11)	781	(11)
Hui (of Xie)	779	21	-	-	-	-
Ping	772	53	(770)	(51)	(770)	(51)

Guowei's interpretations of the specialized terms.[174] The Chronology Project seems to make the same assumptions about the Western Zhou calendar as this study. Therefore, the Chronology Project's interpretations of the specialized terms (hypothesis B) can be confidently rejected (see Table S3).

In order to arrange inscription dates following Wang Guowei's interpretations of the specialized terms, Shaughnessy assumes that some Western Zhou kings maintained two concurrent year counts, adopting the two-*yuan* hypothesis proposed by Nivison.[175] Indeed, this hypothesis was originally motivated by the need to explain why many inscription dates from the same reign are incompatible under Wang Guowei's interpretations. However, the assumption of two concurrent calendars becomes unnecessary if Wang Guowei's interpretations are abandoned: Following the interpretations of the specialized terms deduced in this study, all complete inscription dates can fit in a coherent chronology

174. Shaughnessy, *Sources of Western Zhou History*, 143.

175. Shaughnessy, *Sources of Western Zhou History*, 148; Nivison, "The Dates of Western Chou."

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without the need for extra *yuan* (see Appendix B). This offers a trivial explanation for the difficulties that Nivison and Shaughnessy encountered when arranging inscription dates: Wang Guowei was simply wrong. Therefore, in the absence of direct supporting evidence, the two-*yuan* hypothesis should be rejected.

To sum up, the current evidence shows that Shaughnessy and the Chronology Project made faulty a priori assumptions about the specialized terms, which cannot result in a reliable chronology. In contrast, the interpretations of the specialized terms adopted by this study were rigorously tested against empirical evidence, providing a much more reliable foundation for chronological reconstruction.

APPARENT SIMILARITIES

Since the premises of this study differed significantly from those of Shaughnessy and the Chronology Project, it is only natural that the conclusions are different. The apparent similarities are more noteworthy, and they shall be discussed here.

Shaughnessy and the Chronology Project both propose 1042 B.C.E. as King Cheng's *yuan*. This is based on the dates of "Shao gao," with the understanding that *fei* refers to the first visibility of the waxing crescent (Shaughnessy assumes an additional *yuan* for King Cheng in 1035 B.C.E.). However, they arrived at different conclusions for King Kang's *yuan*, even though both placed the date of "Bi ming feng xing" in King Kang's reign.

The Chronology Project chose 1020 B.C.E. as King Kang's *yuan* in an attempt to accommodate Geng Ying *ding*. As a result, the day of *fei* in "Bi ming feng xing" is four days after *shuo*, which is inconsistent with the Chronology Project's interpretation of *fei* in "Shao gao."[176] In comparison, this study places Geng Ying *ding* in King Mu's reign.

Shaughnessy maintains the date of "Bi ming feng xing" as the first visibility of the lunar crescent, and chooses 1005 B.C.E. as one of King Kang's *yuan*, so that King Cheng's calendar starting in 1035 B.C.E. has a length of thirty years, in agreement with tradition.[177] Although 1005 B.C.E. was a candidate for King Kang's *yuan* considered in this study (Table S11), it was ultimately rejected because King Kang's *yuan* must predate Boqin's death (determined by this study to be in 1008 B.C.E.; see Tables 9 and S12). Shaughnessy assumes a second *yuan* for King Kang

176. Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 28–30.

177. Shaughnessy, *Sources of Western Zhou History*, 242–45.

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in 1003 B.C.E. to accommodate the Lesser Yu *ding* (see n. 177), which this study places in King Zhao's reign.

Shaughnessy also has King Wen receiving the Mandate in 1056 B.C.E. This is counted 100 years (exclusive) from King Mu's *yuan*, proposed by Shaughnessy to be 956 B.C.E. primarily based on the inscription date of the twenty-seventh year Wei *gui*.[178] In this study, although the twenty-seventh year Wei *gui* can also be accommodated in a reign starting in 956 B.C.E., 957 B.C.E. was chosen as King Mu's *yuan* to accommodate the ninth year Wei *ding* as well (Table S7). The year that King Wen received the Mandate was then counted 100 years (inclusive) from King Mu's *yuan* of 957 B.C.E.

Shaughnessy has one of King Gong's *yuan* in 917 B.C.E. to accommodate Qiu Wei *he* as well as the fifth year and ninth year Wei *ding*. However, in order to accommodate the fifteenth year Que Cao *ding*, Shaughnessy further assumed that King Gong established a second *yuan* in 915 B.C.E.[179] In this study, King Gong's *yuan* of 917 B.C.E. was a common solution to the dates of Qiu Wei *he* and the fifteenth year Que Cao *ding* (Table S7), eliminating the need for a second *yuan*.

Shaughnessy and the Chronology Project also proposed 899 B.C.E. as King Yih's *yuan*, based on the record of the "double dawn" in the *Bamboo Annals*.[180] However, whereas this study only uses the *Bamboo Annals* as secondary evidence to choose between two candidates for King Yih's *yuan*, Shaughnessy and the Chronology Project use the *Bamboo Annals* as primary evidence to fix King Yih's *yuan* at 899 B.C.E. As discussed below, the approach adopted by Shaughnessy and the Chronology Project is problematic.

THE "DOUBLE DAWN" AND KING YIH'S *YUAN*

Shaughnessy and the Chronology Project assume that the "double dawn" in King Yih's *yuan* was caused by a solar eclipse, and adopts Pang Sunjoo's proposal dating the eclipse to 899 B.C.E. (see n. 69). However, whether the "double dawn" describes a solar eclipse is uncertain.[181] Moreover, even assuming that the "double dawn" resulted from a solar eclipse, whether the eclipse of 899 B.C.E. could produce such an

178. Shaughnessy, *Sources of Western Zhou History*, 248–54.

179. Shaughnessy, *Sources of Western Zhou History*, 254–55.

180. Shaughnessy, *Sources of Western Zhou History*, 256–57; Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 24–26.

181. Zhang Peiyu, "Zhang taizhang de tianwen niandai yu gutianwen yanjiu" 張台長的天文年代與古天文研究, *Zijinshan tianwentai taikan* 紫金山天文台台刊 21 (2002), 39–54.

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effect in the area of Zheng 鄭[182] is highly dependent on the value of a geophysical parameter *c*.[183] Kevin Pang calculated that *c* must take 29 for this eclipse to produce a "double dawn." The Chronology Project determined that the optimal *c* value for producing a "double dawn" is between 28 and 30, whereas a value greater than 31 would completely eliminate this effect.[184] However, the current best estimate for *c*, obtained by fitting a parabolic curve to a comprehensive set of observational data, is 32.[185] Therefore, empirical evidence does not support identifying the eclipse of 899 B.C.E. as the "double dawn" recorded in the *Bamboo Annals*, although significant uncertainties remain due to limited data.

Based on current evidence, the cause of the "double dawn" in the *Bamboo Annals* cannot be definitively attributed to the eclipse of 899 B.C.E., but the possibility cannot be completely ruled out. This uncertainty means that the "double dawn" cannot serve as reliable primary evidence for computing King Yih's *yuan* and should only be used as secondary evidence. Consistent with this assessment, this study only considered the "double dawn" record after first identifying two candidates for King Yih's *yuan*—899 and 898 B.C.E.—through analysis of bronze inscriptions. 899 B.C.E. was favored over 898 B.C.E. after considering the *possibility* that the "double dawn" may have resulted from a solar eclipse. Therefore, although this study proposes the same solution for King Yih's *yuan* as Shaughnessy and the Chronology Project, the underlying argument is better substantiated by the evidence.

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182. Zheng is usually identified as Huazhou 華州 District of Weinan 渭南 City, formerly known as Hua 華 County.

183. The parameter *c* is used to estimate the value of ΔT, defined as the difference between terrestrial time (TT) and universal time (UT1): $\Delta T = TT - UT1$. TT is a uniform time standard used for astronomical calculations. UT1 is the time standard used in daily life, based on Earth's rotational period with respect to the sun. Since the rate of Earth's rotation is not uniform, ΔT is used to convert between TT and UT1. For the period after 1955, ΔT is determined by atomic clocks and radio observations of quasars. For the period between 500 B.C.E. and 1955 C.E., ΔT is derived from observational records of solar or lunar eclipses (before 1600 C.E.) or lunar occultations (after 1600 C.E.). For the time period before 500 B.C.E., ΔT is extrapolated from the available data using the parabolic formula $\Delta T = c \cdot u^2$, where u = (year − 1820) / 100. The calculated time of day of an eclipse before 500 B.C.E. is thus highly dependent on the value of *c*.

184. Kevin D. Pang, Hung-hsiang Chou, and Robert Wolff, "Computer Analysis of Some Ancient Chinese Sunrise Eclipse Records to Determine the Earth's Rotation Rate," *Vistas in Astronomy* 31 (1988), 833–47; Liu Ciyuan, *Cong tianzaidan dao Wuwang fa Zhou: Xi-Zhou tianwen niandai wenti* 從天再旦到武王伐紂：西周天文年代問題 (Beijing: Shijie tushu, 2006), 77.

185. L. V. Morrison and F. R. Stephenson, "Historical Values of Earth's Clock Error ΔT and the Calculation of Eclipses," *Journal for the History of Astronomy* 35.3 (2004), 327–36.

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DERIVATION OF THE CONQUEST YEAR

Shaughnessy dates the year of the conquest to 1045 B.C.E. primarily based on his proposed "corrections" to the Modern Text *Bamboo Annals*, which assumes a priori that King Wu died two years after the conquest.[186] Shaughnessy also uses the dates of "Wu cheng" to support his conclusion. However, Shaughnessy uses Wang Guowei's interpretation of *jisiba*, which is not supported by the evidence.

The Chronology Project identified three candidates for the year of the conquest: 1046, 1044, and 1027 B.C.E.[187] 1027 B.C.E. was found simply by adding the supposed total years of Western Zhou given in the *Bamboo Annals* (257) to King Ping's *yuan* given in *Shi ji* (770 B.C.E.). This result was quickly discarded by the Chronology Project because it was incompatible with bronze inscription dates. However, this study shows that the *Bamboo Annals* is fully compatible with bronze inscriptions.

1046 B.C.E. was found primarily on the basis of Jupiter's position given in *Guo yu*. Pankenier had first proposed this solution,[188] and the Chronology Project arrived at the same conclusion. However, as shown earlier, Jupiter's position given in *Guo yu* cannot serve as a reliable basis for deriving the year of the conquest.

1044 B.C.E. was found after analyzing Ling Zhou Jiu's description of the other celestial bodies besides Jupiter. To narrow down the results, Jupiter was assumed to be visible in the eastern sky during the army's eastward march, according to *Huainanzi* 淮南子.[189] Jupiter was further assumed to transit the meridian shortly before sunrise on the day of victory (*jiazi* [1]), based on Li Xueqin's interpretation of the inscription of Li *gui* 利簋 (no. 116).[190]

However, it is unclear whether *Huainanzi* accurately describes Jupiter's position: The earlier *Xunzi* 荀子 states that King Wu's army marched east facing the Tai Sui (東面而迎太歲),[191] an imaginary planet. Li Xueqin's reading of the Li *gui* inscription as a description of Jupiter transiting the meridian is also controversial.

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186. Shaughnessy, *Sources of Western Zhou History*, 233; Shaughnessy, "On the Authenticity of the *Bamboo Annals*."

187. Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 46–48.

188. Pankenier, "Astronomical Dates in Shang and Western Zhou."

189. (When) King Wu campaigned against Zhòu, (his army) marched east facing Jupiter (武王伐紂, 東面而迎歲). See *Huainanzi jishi* 淮南子集釋, ed. He Ning 何寧 (Beijing: Zhonghua, 1998), 15.1065 ("Bing lüe xun" 兵畧訓).

190. Li Xueqin, "Ligui ming yu suixing" 利簋銘與歲星, in *Xia Shang Zhou niandaixue zhaji*, 204–5.

191. *Xunzi jijie* 荀子集解, ed. Wang Xianqian 王先謙 (Beijing: Zhonghua, 1988), 4.134 ("Ru xiao" 儒效).

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Depending on the material used, the Chronology Project's astronomical calculations produced two candidates. To reconcile the results, it was suggested that Ling Zhou Jiu may have been describing celestial phenomena spanning two years, from Zhou's initial expedition to King Wu's final victory,[192] implying that there was an initial campaign in 1046 B.C.E., followed by a final victory in 1044 B.C.E. Ultimately, the Chronology Project chose 1046 B.C.E. as the year of the conquest, so that *jisiba* in "Wu cheng" was compatible with the Project's interpretation of the term.[193] However, all the astronomical calculations were based on the unfounded assumption that the received texts preserve accurate descriptions of celestial phenomena during King Wu's campaign.

This study identifies 1046 B.C.E. as the year of the initial expedition (based on the *Bamboo Annals*), and 1044 B.C.E. as the year of the conquest (based on the dates of "Shi fu" and "Wu cheng"), without relying on the position of Jupiter. Although these results appear to agree with the Chronology Project's astronomical calculations, they were derived using different methods under different assumptions, and should not be viewed as validation of the Project's methodology or conclusions.

Breakthrough in Methodology

The methodology developed in this study enables the systematic and unbiased analysis of any number of complete inscription dates within a specified year range, making it possible to simultaneously investigate the relative compatibilities of multiple inscription dates using different interpretations of the specialized terms. This is a major breakthrough in methodology with significant impact.

First, the new methodology makes it possible to use the number of Zhou kings, which is known with certainty, to evaluate whether the various interpretations of the specialized terms are supported by the available evidence. Importantly, this criterion is independent of the meanings of the specialized terms or the absolute dates of Western Zhou, thus overcoming a fundamental methodological deficit that has been a major impediment to progress. As a result, the interpretations of the specialized terms adopted by this study were the result of rigorous empiri-

192. Jiang Xiaoyuan 江曉原 and Niu Weixing 鈕衛星, "Yi tianwenxue fangfa chongxian Wuwang fa Zhou zhi niandai ji richengbiao" 以天文學方法重現武王伐紂之年代及日程表, *Kexue* 科學 51.5 (1999), 25–31; Jiang Xiaoyuan and Niu Weixing, "'*Guo yu*' suozai Wuwang fa Zhou tianxiang jiqi niandai yu richeng" 《國語》所載武王伐紂天象及其年代與日程, *Ziran kexueshi yanjiu* 18.4 (1999), 353–65.

193. Xia Shang Zhou duandai gongcheng zhuanjiazu, *Xia Shang Zhou duandai gongcheng 1996–2000 nian jieduan chengguo baogao: jianben*, 46–48.

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cal analysis, unlike previous studies which were forced to assume the meanings of the specialized terms a priori.

Second, the new methodology offers a powerful way to extract information from bronze inscriptions, thus reducing the reliance on texts whose authenticity and accuracy are generally difficult to establish. Using the new methodology, this study was able to derive the dates of late Western Zhou while disregarding the inaccurate chronology of *Shi ji*. Similarly, this study was able to derive the dates of middle Western Zhou primarily based on bronze inscriptions (complete dates as well as auxiliary information), with only minimal and fragmentary information provided by the *Bamboo Annals*. This feature of the new methodology is especially appealing considering the paucity of reliable information beyond bronze inscriptions.

Finally, the new methodology outlines a general approach that can be broadly applied, even if the details of implementation may vary due to different a priori assumptions. For example, Nivison and Shaughnessy have suggested that the months recorded in the Jin Hou Su *zhong* inscription may follow the local Jin 晉 calendar,[194] rather than the royal Zhou calendar as this study assumes. This would require a different implementation of the criterion to test the interpretations of the specialized terms: An additional reference calendar approximating the local Jin calendar must be constructed and searched for common solutions to the inscription dates of Jin Hou Su *zhong*. Since the Jin Hou Su *zhong* inscription references the king's thirty-third year (隹王卅又三年), these common solutions must correspond to the *yuan* of this king's reign, which can then be compared to the solutions of the other dates derived from the reference calendar approximating the royal Zhou calendar. Therefore, even if one disagrees with the specific premises of this study, the general methodology remains valid and useful for chronological reconstruction.

General Comments and Remaining Questions

The placement of bronze vessels in Appendix B suggests that, in terms of archaeological periodization, the early period of Western Zhou gave way to the middle period in the latter half of King Zhao's reign, and the middle period transitioned to the late period around the reigns of Kings Xiao and Yi. The placement of a number of vessels is rather arbitrary, due to a lack of unique solutions, and may require adjustment as new material is discovered in the future. However, these minor uncertainties do not affect the overall validity of the derived chronology.

194. Nivison and Shaughnessy, "The Jin Hou Su Bells Inscription."

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Despite the discovery of inscription dates in the fourteenth month,[195] this study assumes at most thirteen months per year. This inaccurate assumption is justified by the belief that fourteen-month years were extremely rare, resulting in negligible impact on the historical calendar over the long term. Note that the prohibition of fourteen-month years imposes more stringent constraints on chronological reconstruction.

This study assumes that the Western Zhou calendar year began in the month of *zi* (with an occasional error of one month), following tradition. The successful derivation of a complete chronology under this assumption lends credence to the traditional notion about the Zhou calendar, but does not prove its veracity. This key feature about the historical Western Zhou calendar remains unclear.

This study further assumes that all bronze inscription dates are from the same calendar. The possibility has been raised that some inscription dates may follow local calendar(s) distinct from the royal Zhou calendar. However, to date there are no confirmed examples from the Western Zhou period. Note that the assumption of a single coherent calendar places more stringent constraints on the arrangement of inscription dates as well.

This study assumes an exclusionary relationship between the month and *ganzhi* of *chuji* dates. This additional constraint was added to formulate a testable interpretation of *chuji*. The derived chronology includes three occurrences of two consecutive leap years and an instance of three consecutive leap years (932–931, 915–914, 886–885, and 906–904 B.C.E., see Appendix B), perhaps indicating that this additional constraint imposed on *chuji* dates is too restrictive. However, in absence of more information about intercalation practices, the consecutive leap years are accepted by this study as a genuine feature of the Western Zhou calendar.

Analysis of the specialized terms *jisiba*, *jishengba*, and *jiwang* shows that the Western Zhou calendar month began with the first invisibility of the waning crescent and the calendar day began at sunrise. The distribution of lunar phase errors of the inscription dates suggests that a transition from an observational calendar to a computational one was under way by King Xuan's eighteenth year (810 B.C.E.), if not earlier. This transition was presumably driven by recognition of the lunar conjunction (*shuo*) no later than King You's tenth year. By the early Spring and Autumn period, *shuo* had supplanted *jisiba* as the start of the calendar

195. Li Boqian 李伯謙, "Shuze fangding mingwen kaoshi" 叔矢方鼎銘文考釋, *Wenwu* 2001.8, 39–42; He Bingdi 何炳棣, *He Bingdi sixiang zhidu shilun* 何炳棣思想制度史論 (Taipei: Jinglian, 2013), 131–32; Xu Shaohua 徐少華, "Dengguo tongqi zongkao" 鄧國銅器綜考, *Kaogu* 2013.5, 62–75.

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month, indicating that the transition to a fully computational calendar was complete. This transition also explains the disappearance of the terms *jisiba*, *jishengba*, and *jiwang* from bronze inscriptions in Eastern Zhou.

The usage of *jisiba*, *jishengba*, and *jiwang* is different in inscriptions and texts. This study shows that *jiwang* in texts refers to the first day of the time period governed by *jiwang* in inscriptions. Presumably, the same also holds true for *jisiba* and *jishengba*. The difference in usage may reflect functional differences between texts and inscriptions. Bronze vessels had great ceremonial significance in Western Zhou, and complete inscription dates likely used the specialized terms to indicate auspicious dates chosen by divination. In contrast, the texts considered in this study are primarily historical documents (or presented as such), and likely used specialized terms purely for time reckoning. Complete inscription dates reflect a calendar that crudely divides the lunar cycle into three segments based on the most visible lunar phase changes (visibility of the crescent and appearance of the full moon). However, the additional terms *pangsiba*, *fei*, *zaishengba* 哉生霸, *pangshengba*, and *jipangshengba*, used almost exclusively in texts,[196] suggest the existence of a calendar with finer subdivision of the lunar cycle that was used specifically for time reckoning.

This study demonstrates that the disparate texts of *Xinian*, the (Ancient Text) *Bamboo Annals*, as well as the more credible chapters of *Shang shu* and *Yizhoushu* are all compatible with bronze inscriptions (Appendix B). These texts thus appear to document the same chronology that underlies bronze inscription dates, suggesting that even if the texts may not be contemporaneous with the events they document, they nonetheless contain genuine information. On the other hand, texts that are incompatible with the derived chronology (*Guo yu*, *Lüshi chunqiu*, as well as the less credible chapters from *Yizhoushu* and the Tsinghua bamboo slips) all date to the Spring and Autumn or Warring States period. This suggests that the dates of Western Zhou, especially those of the early period, gradually became obscure in Eastern Zhou.

196. *Pangshengba* may be equivalent to *fangshengba* 方生霸 in the Jin Hou Su *zhong* inscription. The character *fei* appears in inscriptions, but does not describe the lunar phase. An additional term *zaisiba* 哉死霸 was found in oracle bone inscriptions of Zhou origin, see Zhouyuan kaogudui, "2003 nian Shaanxi Qishan Zhougongmiao yizhi diaocha baogao" 2003 年陝西岐山周公廟遺址調查報告, *Gudai wenming* 古代文明 5 (2006), 151–86.

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Conclusion

The methodology developed by this study provides a powerful and adaptable new tool for chronological reconstruction based on rigorous empirical analysis. The application of this new method to the question of Western Zhou chronology has answered longstanding questions regarding the interpretations of the specialized terms, key features of the Western Zhou calendar, as well as the reliability of received and excavated texts. The absolute chronology derived in this study offers the most parsimonious explanation of the available evidence, and establishes a reliable temporal framework for events predating *Chun qiu*. Moreover, this study provides testable hypotheses and raises new questions that can guide future research into Western Zhou archaeology, history, society, and culture.

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Appendix A: Bronze Vessels and Inscription Dates

No.	Name of Donor	Vessel[a]	Year	Month	Day[b]	Specialized Term	Era	Source[c]
1	Shi Hui 師毀	*gui*	1	1	(24)	*chuji*	Late	***JC***: 4311
2	Shi Xun 師訇	*gui*	1	2	(27)	*jiwang*	Late	***SZ***: 5402
3	Ni 逆	*zhong*	1	3	(57)	*jishengba*	Late	***JC***: 60–63
4	Shi Dui 師兌, 1st year	*gui*	1	5	(51)	*chuji*	Late	***JC***: 4274–75
5	Shu Fufu 叔尃父	*xu*	1	6	(24)	*chuji*	Late	***JC***: 4454–57
6	Shi Hu 師虎	*gui*	1	6	(11)	*jiwang*	Middle	***JC***: 4316
7a	Hu 曶	*ding*	1	6	(12)	*jiwang*	Middle	***JC***: 2838
b			*o*[d]	4	(34)	*jishengba*		
8	Bo Lüfu 伯呂父	*xu*	1	6	(47)	*jishengba*	Late	***SZ***: 5635
9	Shi X 師穎	*gui*	1	9	(24)	*jiwang*	Late	***JC***: 4312
10	Wu 吳	*fangyi*	2	2	(24)	*chuji*	Middle	***JC***: 9898
11	Chi 趩	*zhi*	2	3	(52)	*chuji*	Middle	***JC***: 6516
12	Wang Chen 王臣	*gui*	2	3	(27)	*chuji*	Middle	***JC***: 4268

[a]Vessel types: *gui* 簋, *zhong* 鐘, *xu* 盨, *ding* 鼎, *fangyi* 方彝, *zhi* 觶, *he* 盉, *pan* 盤, *hu* 壺, *bo* 鎛, *zun* 尊, *yu* 盂, and *you* 卣.

[b]The corresponding ordinal number of each *ganzhi* date is given, with *jiazi* 甲子 corresponding to (1).

[c]Abbreviations: ***JC***—Zhongguo shehui kexueyuan kaogu yanjiusuo, ed., *Yin Zhou jinwen jicheng* 殷周金文集成 (Beijing: Zhonghua, 2007); ***SZ***—Wu Zhenfeng 吳鎮烽, ed., *Shang Zhou qingtongqi mingwen ji tuxiang jicheng* 商周青銅器銘文暨圖像集成 (Shanghai: Shanghai guji, 2012); ***XB***—Wu Zhenfeng, ed., *Shang Zhou qingtongqi mingwen ji tuxiang jicheng xubian* 商周青銅器銘文暨圖像集成續編 (Shanghai: Shanghai guji, 2016). All numbers are item numbers.

[d]The inscription does not specify the year. Here it is assumed to be the year before the current king's *yuan*: the current king had already succeeded the deceased king, but had not yet established his own *yuan*.

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
13	Shi Dui (= no. 4), 3rd year	*gui*	3	2	(24)	*chuji*	Late	***JC***: 4318–19
14	Qiu Wei 裘衛	*he*	3	3	(39)	*jishengba*	Middle	***JC***: 9456
15	Shi Chen 師晨	*ding*	3	3	(11)	*chuji*	Middle	***JC***: 2817
16	Shi Yu 師俞	*gui*	3	3	(11)	*chuji*	Middle	***SZ***: 5330
17	Shi Ju 師遽	*gui*	3	4	(58)	*jishengba*	Middle	***JC***: 4214
18	Zuo 柞	*zhong*	3	4	(51)	*chuji*	Late	***JC***: 133–39
19	Song 頌	*ding*	3	5	(11)	*jisiba*	Late	***JC***: 2827–29
20	Da 達	*xu*	3	5	(39)	*jishengba*	Middle	***SZ***: 5661–63
21	Xing 癵	*xu*	4	2	(35)	*jishengba*	Middle	***JC***: 4462–63
22	Shi You 師酉	*pan*	4	3	(11)	*jishengba*	Late	***XB***: 951
23	San Bo Chefu 楸伯車父	*ding*	4	8	(24)	*chuji*	Late	***JC***: 2697–700
24	San Ji 楸季	*gui*	4	8	(24)	*chuji*	Late	***JC***: 4126
25	Shi You (= no. 22)	*ding*	4	9	(24)	*chuji*	Middle	***SZ***: 2475
26	Wei 衛, 5th year	*ding*	5	1	(47)	*chuji*	Middle	***JC***: 2832
27	Jian 諫	*gui*	5	3	(27)	*chuji*	Middle	***SZ***: 5336
28	Xi Jia 兮甲	*pan*	5	3	(27)	*jisiba*	Late	***JC***: 10174
29	Shi Shi 師旟, 5th year	*gui*	5	9	(19)	*jishengba*	Late	***JC***: 4216–18
30	Zai Shou 宰獸	*gui*	6	2	(11)	*chuji*	Middle	***SZ***: 5376
31	Shi Bo Shuofu 史伯碩父	*ding*	6	8	(6)	*chuji*	Late	***SZ***: 2424
32	Wo 我	*gui*	7	1	(21)	*chuji*	Middle	***SZ***: 5321
33	Shi Dui (= no. 4), 7th year	*gui*	7	5	(51)	*chuji*	Late	***SZ***: 5302
34	Mu 牧	*gui*	7	13	(51)	*jishengba*	Middle	***JC***: 4343

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
35	Qi Sheng Lu 齊生魯	*fangyi*	8	12	(24)	*chuji*	Middle	***JC***: 9896
36	Wei (= no. 26), 9th year	*ding*	9	1	(17)	*jisiba*	Middle	***JC***: 2831
37	Jun 畯	*gui*	10	1	(51)	*chuji*	King Yih	***SZ***: 5386
38	Guo Jishi Zizu 虢季氏子組	*pan*	11	1	(12)	*chuji*	Late	***Zhou jinwen cun***[e]
39	Shi Li 師麥	*gui*	11	9	(24)	*chuji*	Late	***JC***: 4324–25
40	Taishi Cuo 太師虘	*gui*	12	1	(31)	*jiwang*	Middle	***JC***: 4251–52
41	Guo Jizi Bai 虢季子白	*pan*	12	1	(24)	*chuji*	Late	***SZ***: 10173
42	Zou 走	*gui*	12	3	(27)	*jiwang*	Middle	***SZ***: 5329
43	Da 大	*gui*	12	3	(24)	*jishengba*	Late	***JC***: 4299
44	Wu Qi 無曩	*gui*	13	1	(39)	*chuji*	Late	***JC***: 4225–26
45	Wang 望	*gui*	13	6	(35)	*chuji*	Middle	***JC***: 4272
46	Xing (= no. 21), 13th year	*hu*	13	9	(15)	*chuji*	Middle	***JC***: 9723–24
47	Da (= no. 43), 15th year	*ding*	15	3	(24)	*jishengba*	Late	***SZ***: 2465–67
48	Que Cao 趞曹, 15th year	*ding*	15	5	(19)	*jishengba*	King Gong	***JC***: 2784
49	Bo Ke 伯克	*hu*	16	7	(32)	*jishengba*	Late	***JC***: 9725
50	Ke 克	*bo*	16	9	(27)	*chuji*	Late	***JC***: 209
51	Shi Shan 士山	*pan*	16	9	(21)	*jishengba*	Middle	***SZ***: 14536
52	Ci 此	*ding*	17	12	(52)	*jishengba*	Late	***JC***: 2821–23
53	Shanfu Ke 膳夫克	*xu*	18	12	(27)	*chuji*	Late	***JC***: 4465

[e]Zou An 鄒安, *Zhou jinwen cun* 周金文存 (Shanghai: Cangsheng Mingzhi University, 1916), 4.8.

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
54	Wu Hu 吳虎	*ding*	18	13	(23)	*jishengba*	Late	***SZ***: 2446
55	Ma 趞	*ding*	19	4	(28)	*jiwang*	Late	***JC***: 2815
56	Zouma Xiu 走馬休	*pan*	20	1	(11)	*jiwang*	Middle	***JC***: 10170
57	Geng Ying 庚嬴	*ding*	22	4	(46)	*jiwang*	Middle	***SZ***: 2379
58	Dian 典	*gui*	24	8	(54)	*jiwang*	Middle	***Jincang jicui***[f]
59	Lu 覩	*gui*	24	9	(27)	*jiwang*	Middle	***SZ***: 5362
60	Yu 盂, Lesser	*ding*	25	8	(21)	*jiwang*	Early	***JC***: 2839
61	Pan Ju Sheng 番匊生	*hu*	26	10	(16)	*chuji*	Middle	***JC***: 9705
62	Peng Shu 倗叔	*hu*	26	10	(16)	*chuji*	Middle	***SZ***: 12401
63	Yi 伊	*gui*	27	1	(24)	*jiwang*	Late	***JC***: 4287
64	Wei (= no. 26), 27th year	*gui*	27	3	(35)	*jishengba*	Middle	***JC***: 4256
65	Jin 斮	*gui*	28	1	(4)	*jishengba*	Middle	***SZ***: 5295
66	Huan 寰	*pan*	28	5	(27)	*jiwang*	Late	***JC***: 10172
67	Hu 虎	*gui*	30	4	(11)	*chuji*	Middle	***SZ***: 5399–400
68	Zuoce Wu 作冊吳	*he*	30	4	(19)	*jishengba*	Middle	***SZ***: 14797
69	Guo Bi 鬲比	*ding*	31	3	(29)	*chuji*	Late	***JC***: 2818
70	Dazhu Zhui 大祝追	*ding*	32	8	(18)	*chuji*	Late	***SZ***: 2396

[f]Lü Zhangshen 呂章申, ed., *Jincang jicui: Zhongguo guojia bowuguan xin rucang wenwu* 近藏集粹：中國國家博物館新入藏文物 (Beijing: Beijing shidai huawen, 2016), 76–77.

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
71a	Jin Hou Su 晉侯穌	*zhong*	33	1	(55)	*jishengba*	Late	***SZ***: 15298–313
b			33[g]	2	(40)	*jiwang*		
c			34[h]	2	(39)	*jisiba*		
d			34[i]	6	(15)	*chuji*		
72	Bo Kuifu 伯窺父	*xu*	33	8	(28)	*jisiba*	Late	***JC***: 4438–39
73	Xian 鮮	*gui*	34	5	(55)	*jiwang*	Middle	***JC***: 10166
74	Shanfu Shan 膳夫山	*ding*	37	1	(47)	*chuji*	Late	***JC***: 2825
75	Lai 逨, 42nd year	*ding*	42	5	(52)	*jishengba*	Late	***SZ***: 2501–2
76	Lai (= no. 75), 43rd year	*ding*	43	6	(24)	*jishengba*	Late	***SZ***: 2503–12
77	Shi You (= no. 22)	*gui*	1	1	-	-	Middle	***JC***: 4288
78	He Wan 卻盌	*gui*	1	3	(3)	-	Late	***JC***: 4197
79a	Shi Shi (= no. 29), 1st year	*gui*	1	4	-	*jishengba*	Late	***JC***: 4279–82
b			1	4[j]	(51)			
80	Cai 蔡	*gui*	1	-	(24)	*jiwang*	Middle	***JC***: 4340
81a	Qian 鄑	*gui*	2	1	-	*chuji*	Late	***JC***: 4297
81b	Qian 鄑	*gui*	2	1[k]	(24)	-	Late	***JC***: 4297

[g]Assumed from context.

[h]The third inscription date does not specify the year. However, judging from the month and *ganzhi*, this date cannot be in the same year as date no. 71b. Therefore, this date is placed in the following year.

[i]Assumed from context.

[j]Assumed from context.

[k]Assumed from context.

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
82	Xing (= no. 21)	*ding*	3	4	(7)	-	Middle	***JC***: 2742
83	Scribe Song 史頌	*ding*	3	5	(54)	-	Late	***JC***: 2787–88
84	Xing (= no. 21), 3rd year	*hu*	3	9	(54)	-	Middle	***JC***: 9726–27
85	Diaosheng 琱生, 5th year	*gui*	5	1	(26)	-	Late	***JC***: 4292
86	He 冓	*zun*	5	4	(23)	-	Early	***JC***: 6014
87	Diaosheng (= no. 85)	*zun*	5	9	-	*chuji*	Late	***SZ***: 11816–17
88	Hu 獄	*zhong*	5	-	-	-	King Li	***JC***: 358
89	Diaosheng (= no. 85), 6th year	*gui*	6	4	(1)	-	Late	***JC***: 4293
90	Que Cao (= no. 48), 7th year	*ding*	7	10	-	*jishengba*	Middle	***JC***: 2783
91	Shi Zai 師㝬	*ding*	8	1	(4)	-	King Gong	***JC***: 2830
92	Guai Bo 乖伯	*gui*	9	9	(51)	-	Middle	***JC***: 4331
93	Yong 永	*yu*	12	-	(4)	*chuji*	Middle	***JC***: 10322
94	Hu (= no. 88)	*gui*	12	-	-	-	King Li	***JC***: 4317
95	Duan 段	*gui*	14	11	(4)	-	Middle	***JC***: 4208
96	Da (= no. 43)	*gui*	15	6	-	-	Late	***JC***: 4125
97	Cheng 成	*zhong*	16	9	(24)	-	Late	***SZ***: 15264
98	Xun 訇	*gui*	17	-	-	-	Middle	***JC***: 4321
99	Jufu 駒父	*xu*	18	1	-	-	Late	***JC***: 4464
100	Zuoce Zhe 作冊折	*fangyi*	19	5	(25)	-	Early	***JC***: 9895
101a	Wen 文	*xu*	23	8	-	-	Late	***SZ***: 5664–65
b			24[1]	5	-	*chuji*		

[1]Assumed from context.

Appendix A (continued)

No.	Name of Donor	Vessel	Year	Month	Day	Specialized Term	Era	Source
102	Yu (= no. 60), Greater	*ding*	23	9	-	-	Early	***JC***: 2837
103	Ke (= no. 50), Lesser	*ding*	23	9	-	-	Late	***JC***: 2796–802
104	Wei Luan 微鑾	*ding*	23	9	-	-	Late	***JC***: 2790
105	Peng Bo Cheng 倗伯再	*gui*	23	-	(35)	*chuji*	Middle	***SZ***: 5208
106	Guo Bi (= no. 69)	*xu*	25	7	*Ill.*[m]	-	Late	***JC***: 4466
107	Yao Gong 覓公	*gui*	28	-	-	-	Early	***SZ***: 4954
108	Dou Bi 豆閉	*gui*	-	2	(15)	*jishengba*	Middle	***JC***: 4276
109	Shi Yun 師瘐	*gui*	-	2	(15)	*chuji*	Middle	***JC***: 4283–84
110	Chang Fu 長由	*he*	-	3	(24)	*chuji*	King Mu	***JC***: 9455
111	Kuang 匡	*you*	-	4	(31)	*chuji*	King Yih	***JC***: 5423
112	Shi Kuifu 師奎父	*ding*	-	6	(27)	*jishengba*	Middle	***JC***: 2813
113	Yang 揚	*gui*	-	9	(27)	*jishengba*	Late	***JC***: 4294–95
114a	Fan 鄱	*you*	-	9	(50)	*chuji*	Middle	***JC***: 5430
b			-	-	(48)	-		
115	Fushi Li 輔師嫠	*gui*	-	9	(51)	*jishengba*	Late	***JC***: 4286
116	Li 利	*gui*	-	-	(1)	-	Early	***JC***: 4131
117	Xing (= no. 21)	*zhong*	-	-	-	-	Middle	***JC***: 246
118	Scribe Qiang 史牆	*pan*	-	-	-	-	King Gong	***JC***: 10175
119	Lai (= no. 75)	*pan*	-	-	-	-	King Xuan	***SZ***: 14543
120	Ke (= no. 50), Greater	*ding*	-	-	-	-	Late	***JC***: 2836

[m]Illegible.

Appendix B: The Reconstructed Absolute Chronology of Zhou

B.C.E.	Calendar Year No.[d]	Start[e]	Length[f]	King	Year	Material	Recorded Date[a]	JDN[b]	Remark[c]
1056	95			WEN	*yuan*				Receives Mandate
1055	96				2				
1054	97				3				
1053	98				4				
1052	99				5				
1051	100				6				
1050	101				7				
1049	102				8				
1048	103				9				
1047	104				10				

[a]Date format: regnal year / ordinal month / (*ganzhi* sequence number) / specialized term. Missing information is represented by "-". Abbreviations: PShB—*pangshengba*; JPShB—*jipangshengba*; PSiB—*pangsiba*; JShB—*jishengba*; JSiB—*jisiba*; JW—*jiwang*; CJ—*chuji*.

[b]JDN: Julian day number. JDN to calendar date conversion tool is provided in Supplementary Material.

[c]The index numbers of inscription dates in Appendix A are provided. When applicable, the lunar phase of the date is expressed as the number of days removed from *shuo* 朔 (the day of lunar conjunction) or *wang* 望 (the day of lunar opposition). If the date falls on the day before lunar conjunction, it is referred to as *hui* 晦.

[d]Calendar year of the reference calendar, see Table S1.

[e]The first month of the year in the Zhou calendar: *Hai* 亥—month containing the solar term *xiaoxue* 小雪; *Zi* 子—month containing the winter solstice; *Chou* 丑—month containing the solar term *dahan* 大寒.

[f]The number of lunar months in a calendar year.

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
1046	105	*Hai*	12	Wu[g]	11	Shi fu	-/S1/(53)/PShB[h]	1339383	*Wang* – 1
1045	106	*Hai*	12		12				
1044	107	*Hai*	N.D.[i]		13	Wu cheng	-/S1/(29)/PSiB[h]	1340079	*Shuo* + 1
						Shi fu & Wu cheng	-/3/(57)/JSiB	1340107	*Hui*
						Shi fu & Wu cheng	-/3/(1)/-	1340111	Shang is defeated
						Shi fu & Wu cheng	-/4/(42)/JPShB	1340152	*Wang*
1043	108				14				
1042	109			Cheng	*yuan*				
1041	110				2				
1040	111				3				
1039	112				4				
1038	113	*Zi*	12		5	He *zun*	5/4/(23)/-	1342353	No. 86; *Shuo* + 1
1037	114	*Hai*	12		6				
1036	115	*Hai*	N.D.		7	Shao gao	-/2/(27)/JW	1343017	*Wang* + 1
						Shao gao	-/3/(43)/*fei*	1343033	*Shuo* + 2
1035	116				8				

[g]The exact year of King Wu's succession was not determined.
[h]S1: the first month of the Shang calendar.
[i]N.D.: not determined.

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
1034	117				9				
1033	118			Cheng	10				
1032	119				11				
1031	120				12				
1030	121				13				
1029	122				14				
1028	123				15				
1027	124				16				
1026	125				17				
1025	126				18				
1024	127				19				
1023	128				20				
1022	129				21				
1021	130				22				
1020	131				23				
1019	132				24				
1018	133				25				
1017	134				26				
1016	135				27				
1015	136	N.D.	N.D.		28	Yao Gong *gui*	28/-/-/-	N.D.	No. 107
1014	137				29				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
1013	138				30				
1012	139			Cheng	31				
1011	140	*Zi*	N.D.		32	Gu ming[j]	-/4/(1)/-	1352231	*Wang* + 1
						Gu ming[j]	-/4/(2)/-	1352232	King Cheng dies
1010	141			Kang	*yuan*				
1009	142				2				
1008	143				3				
1007	144				4				
1006	145				5				
1005	146				6				
1004	147				7				
1003	148				8				
1002	149				9				
1001	150				10				
1000	151				11				
999	152	*Zi*	N.D.		12	Bi ming feng xing	12/6/(7)/*fei*	1356677	*Shuo* + 2
998	153				13				
997	154				14				

[j] *Shang shu zhengyi*, 18.583b, 587b ("Gu ming" 顧命).

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
996	155				15				
995	156				16				
994	157			Kang	17				
993	158				18				
992	159	*Chou*	N.D.		19	Zuoce Zhe *fangyi*	19/5/(25)/-	1359215	No. 100; *Shuo* + 1
991	160			Zhao	*yuan*				
990	161				2				
989	162				3				
988	163				4				
987	164				5				
986	165				6				
985	166				7				
984	167				8				
983	168				9				
982	169				10				
981	170				11				
980	171				12				
979	172				13				
978	173				14				
977	174				15				
976	175				16				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
975	176				17				
974	177				18				
973	178			Zhao	19				
972	179				20				
971	180				21				
970	181				22				
969	182	N.D.	N.D.		23	Greater Yu *ding*	23/9/-/-	N.D.	No. 102
968	183	*Zi*	13		24	Dian *gui*	24/8/(54)/JW	1368064	No. **58**; *Wang* + 6
						Lu *gui*	24/9/(27)/JW	1368097	No. **59**; *Wang* + 9
967	184	*Zi*	N.D.		25	Lesser Yu *ding*	25/8/(21)/JW	1368451	No. **60**; *Wang* + 9
966	185				26				
965	186				27				
964	187				28				
963	188				29				
962	189				30				
961	190				31				
960	191				32				
959	192				33				
958	193	*Chou*	N.D.		34	Xian *gui*	34/5/(55)/JW	1371665	No. **73**; *Wang* + 4
957	194			Mu	*yuan*				
956	195				2				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
955	196				3				
954	197				4				
953	198			Mu	5				
952	199				6				
951	200				7				
950	201				8				
949	202	*Chou*	12		9	9th yr. Wei *ding*	9/1/(17)/JSiB	1374807	No. **36**; *Shuo* + 1
948	203	*Zi*	12		10				
947	204	*Zi*	12		11				
946	205	*Zi*	N.D.		12	Zou *gui*	12/3/(27)/JW	1375957	No. **42**; *Hui*
945	206				13				
944	207				14				
943	208				15				
942	209				16				
941	210				17				
940	211				18				
939	212				19				
938	213	*Zi*	N.D.		20	Zouma Xiu *pan*	20/1/(11)/JW	1378821	No. **56**; *Hui*
937	214				21				
936	215	*Zi*	N.D.		22	Geng Ying *ding*	22/4/(46)/JW	1379636	No. **57**; *Wang* + 2

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
935	216	N.D.	N.D.		23	Peng Bo Cheng *gui*	23/-/(35)/CJ	N.D.	No. 105; Theoretical date
934	217				24				
933	218				25				
932	219	*Hai*	13	Mu	26	Pan Ju Sheng *hu*	26/10/(16)/CJ	N.D.	No. **61**; Theoretical date
						Peng Shu *hu*	26/10/(16)/CJ	N.D.	No. **62**; Theoretical date
931	220	*Zi*	13		27	27th yr. Wei *gui*	27/3/(35)/JShB	1381425	No. **64**; *Shuo* + 4
930	221	*Chou*	12		28	Jin *gui*	28/1/(4)/JShB	1381754	No. **65**; *Shuo* + 8
929	222	*Zi*	12		29				
928	223	*Zi*	N.D.		30	Hu *gui*	30/4/(11)/CJ	N.D.	No. **67**; Theoretical date
						Zuoce Wu *he*	30/4/(19)/JShB	1382549	No. **68**; *Shuo* + 6
927	224				31				
926	225				32				
925	226				33				
924	227				34				
923	228				35				
922	229				36				
921	230				37				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
920	231				38				
919	232				39				
918	233				40				
917	234	N.D.	N.D.	Gong	*yuan*	Shi You *gui*	1/1/-/-	N.D.	No. 77
						Cai *gui*	1/-/(24)/JW	N.D.	No. 80
916	235	*Zi*	12		2	Wang Chen *gui*	2/3/(27)/CJ	N.D.	No. **12**; Theoretical date
915	236	*Hai*	13		3	Qiu Wei *he*	3/3/(39)/JShB	1387249	No. **14**; *Shuo* + 10
914	237	*Zi*	13	Gong	4				
913	238	*Zi*	12		5	5th yr. Wei *ding*	5/1/(47)/CJ	N.D.	No. **26**; Theoretical date
912	239	*Zi*	12		6				
911	240	*Zi*	12		7	7th yr. Que Cao *ding*	7/10/-/JShB	N.D.	No. 90
910	241	*Hai*	12		8	Shi Zai *ding*	8/1/(4)/-	1389014	No. 91; *Shuo* + 4
909	242	*Hai*	N.D.		9	Guai Bo *gui*	9/9/(51)/-	1389601	No. 92; *Shuo*
908	243				10				
907	244				11				
906	245	*Hai*	13		12	Taishi Cuo *gui*	12/1/(31)/JW	1390481	No. **40**; *Wang* + 9
						Yong *yu*	12/-/(4)/CJ	N.D.	No. 93; Theoretical date

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
905	246	*Zi*	13		13	Wang *gui*	13/6/(35)/CJ	N.D.	No. **45**; Theoretical date
						13th yr. Xing *xu*	13/9/(15)/CJ	N.D.	No. **46**; Theoretical date
904	247	*Zi*	13		14	Duan *gui*	14/11/(4)/-	1391534	No. 95; *Shuo* + 14
903	248	*Chou*	12		15	15th yr. Que Cao *ding*	15/5/(19)/JShB	1391729	No. **48**; *Shuo* + 2
902	249	*Zi*	N.D.		16	Shi Shan *pan*	16/9/(21)/JShB	1392211	No. **51**; *Shuo* + 12
901	250	N.D.	N.D.		17	Xun *gui*	17/-/-/-	N.D.	No. 98
900	251				18				
899	252	*Zi*	12	Yih	*yuan*	Shi Hu *gui*	1/6/(11)/JW	1393221	No. **6**; *Wang* + 3
898	253	*Zi*	12		2	Wu *fangyi*	2/2/(24)/CJ	N.D.	No. **10**; Theoretical date
897	254	*Zi*	12		3	Shi Ju *gui*	3/4/(58)/JShB	1393868	No. **17**; *Wang*
896	255	*Hai*	N.D.		4	Shi You *pan*	4/3/(11)/JShB	1394181	No. **22**; *Shuo* + 2
895	256			Yih	5				
894	257				6				
893	258	*Zi*	13		7	Mu *gui*	7/13/(51)/JShB	1395601	No. **34**; *Shuo* + 6
892	259	*Chou*	12		8	Qi Sheng Lu *fangyi*	8/12/(24)/CJ	N.D.	No. **35**; Theoretical date
891	260	*Zi*	12		9				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
890	261	*Zi*	12		10	Jun *gui*	10/1/(51)/CJ	N.D.	No. **37**; Theoretical date
889	262	*Zi*	12		11				
888	263	*Hai*	13		12	Hu *ding*	0/4/(34)/JShB	1397144	No. **7b**; *Shuo* + 13
887	264	*Zi*	12	Xiao	*yuan*	Hu *ding*	1/6/(12)/JW	1397602	No. **7a**; *Hui*
886	265	*Zi*	13		2	Chi *zhi*	2/3/(52)/CJ	N.D.	No. **11**; Theoretical date
885	266	*Zi*	13		3	Shi Chen *ding*	3/3/(11)/CJ	N.D.	No. **15**; Theoretical date
						Shi Yu *gui*	3/3/(11)/CJ	N.D.	No. **16**; Theoretical date
						Xing *ding*	3/4/(7)/-	1398257	No. 82; *Shuo* + 3
						Da *xu*	3/5/(39)/JShB	1398289	No. **20**; *Shuo* + 6
						3rd yr. Xing *hu*	3/9/(54)/-	1398424	No. 84; *Wang* + 8
884	267	*Chou*	12		4	Xing *xu*	4/2/(35)/JShB	1398585	No. **21**; *Shuo* + 7
						Shi You *ding*	4/9/(24)/CJ	N.D.	No. **25**; Theoretical date
883	268	*Zi*	12		5	Jian *gui*	5/3/(27)/CJ	N.D.	No. **27**; Theoretical date
882	269	*Zi*	12		6	Zai Shou *gui*	6/2/(11)/CJ	N.D.	No. **30**; Theoretical date

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
881	270	*Zi*	N.D.	Yi	*yuan*	Shi Xun *gui*	1/2/(27)/JW	1399657	No. **2**; *Wang* + 1
						He Wan *gui*	1/3/(3)/-	1399693	No. 78; *Wang* + 7
880	271			Yi	2				
879	272				3				
878	273				4				
877	274				5				
876	275				6				
875	276	*Zi*	N.D.		7	Wo *gui*	7/1/(21)/CJ	N.D.	No. **32**; Theoretical date
874	277				8				
873	278				9				
872	279				10				
871	280				11				
870	281	*Chou*	12	Li	*yuan*	1st yr. Shi Shi *gui*	1/4/(51)/-	1403761	No. 79b; *Wang*
	281	*Chou*	12			1st yr. Shi Dui *gui*	1/5/(51)/CJ	N.D.	No. **4**; Theoretical date
						Bo Lüfu *xu*	1/6/(47)/JShB	1403817	No. **8**; *Shuo* + 12
						Shu Fufu *xu*	1/6/(24)/CJ	N.D.	No. **5**; Theoretical date
						Shi X *gui*	1/9/(24)/JW	1403914	No. **9**; *Wang* + 6
869	282	*Zi*	12		2				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
868	283	*Zi*	N.D.		3	3rd yr. Shi Dui *gui*	3/2/(24)/CJ	N.D.	No. **13**; Theoretical date
867	284				4				
866	285	*Zi*	13		5	5th yr. Diaosheng *gui*	5/1/(26)/-	1405116	No. 85; *Shuo* + 12
						5th yr. Shi Shi *gui*	5/9/(19)/JShB	1405349	No. **29**; *Shuo* + 8
						Diaosheng *zun*	5/9/-/CJ	N.D.	No. 87; Theoretical date
866	285	*Zi*	13	Li	5	Hu *zhong*	5/-/-/-	N.D.	No. 88
865	286	*Zi*	12		6	6th yr. Diaosheng *gui*	6/4/(1)/-	1405571	No. 89; *Wang* + 9
864	287	*Hai*	N.D.		7	7th yr. Shi Dui *gui*	7/5/(51)/CJ	N.D.	No. **33**; Theoretical date
863	288				8				
862	289				9				
861	290				10				
860	291	*Zi*	N.D.		11	Shi Li *gui*	11/9/(24)/CJ	N.D.	No. **39**; Theoretical date
859	292	N.D.	N.D.		12	Hu *gui*	12/-/-/-	N.D.	No. 94
858	293	*Zi*	N.D.		13	Wu Qi *gui*	13/1/(39)/CJ	N.D.	No. **44**; Theoretical date

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
857	294				14				
856	295	*Zi*	13		15	15th yr. Da *ding*	15/3/(24)/JShB	1408834	No. **47**; *Shuo* + 9
855	296	*Chou*	12		16	Ke *bo*	16/9/(27)/CJ	N.D.	No. **50**; Theoretical date
854	297	*Chou*	12		17				
853	298	*Zi*	N.D.		18	Shanfu Ke *xu*	18/12/(27)/CJ	N.D.	No. **53**; Theoretical date
852	299				19				
851	300				20				
850	301				21				Gonghe Regency starts
849	302				22				
848	303	N.D.	N.D.		23	Lesser Ke *ding*	23/9/-/-	N.D.	No. 103
						Wei Luan *ding*	23/9/-/-	N.D.	No. 104
847	304				24				
846	305	N.D.	N.D.	Li	25	Guo Bi *xu*	25/7/*Ill.* /-	N.D.	No. 106
845	306				26				
844	307	*Zi*	N.D.		27	Yi *gui*	27/1/(24)/JW	1413154	No. **63**; *Wang* + 3
843	308				28				
842	309				29				
841	310				30				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
840	311	*Chou*	13		31	Guo Bi *ding*	31/3/(29)/CJ	N.D.	No. **69**; Theoretical date
839	312	*Chou*	12		32	Dazhu Zhui *ding*	32/8/(18)/CJ	N.D.	No. **70**; Theoretical date
838	313	*Chou*	12		33	Bo Kuifu *xu*	33/8/(28)/JSiB	1415558	No. **72**; *Shuo*
837	314	*Zi*	12		34				Gonghe Regency ends
836	315	*Zi*	12	Xuan	*yuan*	Shi Hui *gui*	1/1/(24)/CJ	N.D.	No. **1**; Theoretical date
835	316	*Zi*	12		2				
834	317	*Hai*	13		3	Zuo *zhong*	3/4/(51)/CJ	N.D.	No. **18**; Theoretical date
						Scribe Song *ding*	3/5/(54)/-	1416904	No. 83; *Wang* + 2
833	318	*Zi*	13		4	San Bo Chefu *ding*	4/8/(24)/CJ	N.D.	No. **23**; Theoretical date
						San Ji *gui*	4/8/(24)/CJ	N.D.	No. **24**; Theoretical date
832	319	*Chou*	N.D.		5	Xi Jia *pan*	5/3/(27)/JSiB	1417597	No. **28**; *Shuo* + 1
831	320				6				
830	321				7				
829	322				8				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
828	323				9				
827	324			Xuan	10				
826	325				11				
825	326	*Chou*	N.D.		12	Da *gui*	12/3/(24)/JShB	1420174	No. **43**; *Shuo* + 9
824	327				13				
823	328				14				
822	329	N.D.	N.D.		15	Da *gui*	15/6/-/-	N.D.	No. 96
821	330	*Chou*	12		16	Bo Ke *hu*	16/7/(32)/JShB	1421742	No. **49**; *Shuo* + 12
						Cheng *zhong*	16/9/(24)/-	1421794	No. 97; *Shuo* + 5
820	331	*Zi*	12		17	Ci *ding*	17/12/(52)/JShB	1422242	No. **52**; *Shuo* + 10
819	332	*Zi*	13		18	Jufu *xu*	18/1/-/-	N.D.	No. 99
						Wu Hu *ding*	18/13/(23)/JShB	1422633	No. **54**; *Wang* + 2[k]
818	333	*Zi*	N.D.		19	Ma *ding*	19/4/(28)/JW	1422758	No. **55**; *Wang* + 9
817	334				20				
816	335				21				
815	336				22				
814	337	N.D.	N.D.		23	Wen *xu*	23/8/-/-	N.D.	No. 101a

[k]Lunar phase error.

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
813	338	N.D.	N.D.		24	Wen *xu*	24/5/-/CJ	N.D.	No. 101b; Theoretical date
812	339				25				
811	340				26				
810	341			Xuan	27				
809	342	*Zi*	N.D.		28	Huan *pan*	28/5/(27)/JW	1426057	No. **66**; *Wang*
808	343				29				
807	344				30				
806	345				31				
805	346				32				
804	347	*Zi*	13		33	Jin Hou Su *zhong*	33/1/(55)/JShB	1427765	No. **71a**; *Shuo* + 11
						Jin Hou Su *zhong*	33/2/(40)/JW	1427810	No. **71b**; *Wang* + 11
803	348	*Chou*	12		34	Jin Hou Su *zhong*	34/2/(39)/JSiB	1428169	No. **71c**; *Shuo* + 1
						Jin Hou Su *zhong*	34/6/(15)/CJ	N.D.	No. **71d**; Theoretical date
802	349	*Zi*	12		35				
801	350	*Zi*	12		36				
800	351	*Zi*	N.D.		37	Shanfu Shan *ding*	37/1/(47)/CJ	N.D.	No. **74**; Theoretical date

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
799	352				38				
798	353				39				
797	354				40				
796	355				41				
795	356	*Chou*	12		42	42nd yr. Lai *ding*	42/5/(52)/JShB	1431182	No. **75**; *Shuo* + 2
794	357	*Chou*	N.D.		43	43rd yr. Lai *ding*	43/6/(24)/JShB	1431574	No. **76**; *Shuo* + 10
793	358				44				
792	359				45				
791	360			Xuan	46				
790	361	*Zi*	13	You	*yuan*	Ni *zhong*	1/3/(57)/JShB	1432927	No. **3**; *Shuo* + 4
789	362	*Chou*	12		2	Qian *gui*	2/1/(24)/-	1433254	No. 81b; *Shuo* + 7
788	363	*Zi*	12		3	Song *ding*	3/5/(11)/JSiB	1433721	No. **19**; *Shuo* + 1
787	364	*Zi*	12		4				
786	365	*Zi*	12		5				
785	366	*Hai*	N.D.		6	Shi Bo Shuofu *ding*	6/8/(6)/CJ	N.D.	No. **31**; Theoretical date
784	367				7				
783	368				8				
782	369				9				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
781	370	*Zi*	12		10	Shiyue zhi jiao	-/10[l]/(28)/*shuo*	1436318	Solar eclipse
780	371	*Hai*	N.D.		11	Guo Jishi Zizu *pan*	11/1/(12)/CJ	N.D.	No. **38**; Theoretical date
779	372			Hui[m]	*yuan*				
778	373				2				
777	374				3				
776	375				4				
775	376				5				
774	377				6				
773	378			Hui	7				
772	379				8				King Ping's *yuan*
771	380				9				
770	381				10				King Ping moves east
769	382				11				
768	383	*Zi*	N.D.		12	Guo Jizi Bai *pan*	12/1/(24)/CJ	N.D.	No. **41**; Theoretical date

[l]The "tenth month" in the transmitted text is a mistranscription of the "seventh month".
[m]King Hui of Xie. See Table 2 for a more detailed chronology of this period.

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
767	384				13				
766	385				14				
765	386				15				
764	387				16				
763	388				17				
762	389				18				
761	390				19				
760	391				20				
759	392				21				King Hui of Xie killed
758	393			Ping	15				
757	394				16				
756	395				17				
755	396				18				
754	397				19				
753	398				20				
752	399			Ping	21				
751	400				22				
750	401				23				
749	402				24				
748	403				25				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
747	404				26				
746	405				27				
745	406				28				
744	407				29				
743	408				30				
742	409				31				
741	410				32				
740	411				33				
739	412				34				
738	413				35				
737	414				36				
736	415				37				
735	416				38				
734	417				39				
733	418				40				
732	419				41				
731	420			PING	42				
730	421				43				
729	422				44				
728	423				45				
727	424				46				

Appendix B (continued)

	Calendar Year								
B.C.E.	No.	Start	Length	King	Year	Material	Recorded Date	JDN	Remark
726	425				47				
725	426				48				
724	427				49				
723	428				50				
722	429				51	*Chun qiu*			Lord Yin of Lu's *yuan*
721	430				52				
720	431	*Chou*	N.D.		53	*Chun qiu*	Y3/W2/(6)/-[n]	1458496	Solar eclipse
						Chun qiu	Y3/3/(47)/-[o]	1458537	King Ping dies

[n] *Chun qiu zuo zhuan zhengyi*, 3.78a (Yin 3). Y3: the third year of Lord Yin of Lu; W2: the second month of the royal calendar (王二月).

[o] *Chun qiu zuo zhuan zhengyi*, 3.79b (Yin 3). *Zuo zhuan* gives Y3/W3/(59)/- as the date of King Ping's death (王三月壬戌, 平王崩), which is JDN 1458549, see *Chun qiu zuo zhuan zhengyi*, 3.82a–b (Yin 3).

Appendix C: Individuals Appearing Across Multiple Inscriptions

Title or Name	Appearances[a]	Active Years (B.C.E.)[b] Earliest	Latest	Span[c]
Yu 盂	102, **60**	969	967	3
Qiu Wei 裘衛	**36**, **64**, **14**, **26**	949	913	37
Mei Ao 眉敖	**36**, 92	949	909	41
Sima Xing Bo Lu 司馬邢伯親	**59**, **42**, 112, 109[d]	968	post-946	>23
Jing Bo 井伯	110,[e] 108, **26**, 90, 93, **6**	pre-917	899	>18
Jing Shu 井叔	**7**, **11**, **20**	887	885	3
Yi Gong 益公	**56**, **57**, 105, **12**, 92, 93, 98	938	901	38
Kang Gong 康公	**37**, 78	890	881	10
Wu 吳[f]	**68**, 109, **6**, **10**, **34**	928	893	36
Hu 虎	**67**, **6**	928	899	30
Que Cao 趞曹	90, **48**	911	903	9

[a]Item numbers from Appendix A are listed in chronological order.

[b]The earliest and latest year determined by bronze inscriptions. If uncertain, the year is expressed in relation to the closest year known with certainty.

[c]Span of years calculated by inclusive counting.

[d]Inscription mentions both Sima Xing Bo Lu and Interior Scribe Wu 内史吳 without recording the regnal year. Considering Wu's active years, this vessel should postdate Zou *gui* (no. 42).

[e]Inscription places the vessel firmly in King Mu's reign, thus predating King Gong's *yuan*.

[f]Interior Scribe Wu is identified with Zuoce Wu 作冊吳.

Appendix C (continued)

Title or Name	Appearances	Active Years (B.C.E.) Earliest	Latest	Span
Kuifu 奎父	112,[g] 93	pre-928	906	>23
Shi Xi 師戲	**67**, 108[h]	928	pre-899	<30
Scribe Nian 史年[i]	80, **12**, **45**, 113, **21**, **27**	917	883	45
Sufu 俗父[j]	**26**, 93, **15**, **25**	913	884	30
Rong Bo 榮伯	93, 115, **30**, **2**	906	881	26
Xun 訇	98, **2**	901	881	21
Shi Li 師麥	115, **39**	pre-882	860	>23
Shi Chen 師晨	**40**, **15**	906	885	22
Zai Hu 宰智	80, **40**	917	906	12
Shi You 師酉	77, **22**, **25**	917	884	34
Xing 癵	**46**, 82, 84, **21**	905	884	22
Scribe Qiang 史牆	77, 118, **22**	917	896	22
Chi 趩	**11**, **20**	886	885	2
Sima Gong 司馬共	**15**, **16**, **21**, **27**	885	883	3

[g]According to inscription, Sima Xing Bo is the right-hand convoy, and the king calls out Interior Scribe Ju 駒. This vessel is thus assumed to predate Interior Scribe Wu.

[h]Inscription states that the king is in Shi Xi's 師戲 great hall大室.

[i]Personal name alternatively transcribed as Ao 敖 or Mei 尾.

[j]Bo Sufu 伯俗父, Shi Sufu 師俗父, and Shi Su 師俗, are assumed to be the same person.

Appendix C (continued)

Title or Name	Appearances	Active Years (B.C.E.) Earliest	Latest	Span
Shen Ji 豳季	**26**, 120, **63**	913	844	70[k]
Diaosheng 琱生	85, 87, 89, **39**	866	860	7
Chi Gong 遲公	79, **63**[l]	870	pre-844	<27
Hefu 穌父[m]	**4**, **13**, **39**, **1**	870	836	35
Da 大	**47**, **43**, 96	856	822	35
Ke 克[n]	**50**, **53**, 103, 106, 120, **49**	855	821	35
Shi Dui 師兌	**4**, **13**, **33**	870	864	7
Shi Shi 師簋	79, **29**	870	866	5
Guo Bi 虢比	106, **69**	846	840	7
Scribe Yu 史淢	**66**, **75**, **76**	809	794	16
Lai 逨	**75**, 119, **76**	795	794	2

[k]Shen Ji in the fifth year Wei *ding* (no. 26) inscription may have been a different individual from Shen Ji in the inscriptions of Greater Ke *ding* and Yi *gui* (nos. 120, 63), see Xu Yanyu 徐雁宇, "Shenji zhuqi nianshi yu xuanshi zuqi" 申季諸器年世與宣世組器, *Kaogu* 2016.9, 105–9.

[l]Inscription names donor's deceased father as Chi Shu 虢叔, who is identified with Chi Gong.

[m]Shi Hefu 師穌父 is identified with Bo Hefu 伯穌父, who is identified with Gong Bo He 共伯和 by Guo Moruo, see Guo Moruo, *Liang-Zhou jinwenci daxi tulu kaoshi*, vol. 8, 114.

[n]Bo Ke is identified with Ke.