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B. Hipparchus (Second Century BCE)

The great astronomer Claudius Ptolemaeus (ca. 100–ca. 170 CE), a Greek-speaking Egyptian who probably spent most of his life in Alexandria,[16] uses Babylonian observations. How did this information travel from Babylon to Alexandria, shifting from clay to papyrus, from tablet to roll, from Babylonian to Greek language, and from lunisolar calendar to Egyptian civil calendar? It is now generally accepted that Greek astronomy is indebted in many ways to Babylonian astronomy.[17] An example of borrowing is the sexagesimal system. It must have been during the transfer of astronomical knowledge that dates according to the Babylonian lunisolar calendar were converted to the Egyptian year of 365 days used in the Canon. Ptolemy himself does not seem to have been involved in the conversion (cf. Aaboe 1991, 290). Everything points to Hipparchus, that other great Greek astronomer (see already Ideler 1806, 173).[18] It has even been suggested, as a probable historical scenario, that Hipparchus "must have visited Babylon, have persuaded one or more of the astronomer scribes there to communicate to him enough of their records and methods for him to grasp the extent of the first and basic principles of the second, and have spent enough time there to have his informant extract and translate for him a considerable number of observations" (Toomer 1988, 359).[19] Most of Hipparchus's work is lost, but Ptolemy uses it while giving due credit. Since some of Ptolemy's Babylonian observations are explicitly attributed to Hipparchus, Hipparchus may well have been the source of all of them (Toomer 1988, 353, note 2). Furthermore, Pliny's statement (*Natural History* II, 53) that Hipparchus predicted solar and lunar eclipse records for a period of 600 years has very plausibly been interpreted as a "misunderstanding of a compilation by Hipparchus of eclipse records for the 600 years preceding his time, that is, stretching back to the reign of Nabonassar" (Toomer 1988, 355, referring to Neugebauer 1975, 1:319–21).

When the Babylonian dates had to be converted, perhaps by Hipparchus, the Egyptian calendar may have been chosen for its simplicity. On the other hand, Egypt controlled a good part of the Eastern Mediterranean for much of the third and second centuries BCE. The calendar was therefore probably well known outside Egypt and therefore an obvious choice. Hipparchus spent his later years in Rhodes (Toomer 1978, 207–8).

For the purpose of establishing the exact Egyptian date for each Babylonian date, meticulous records of the lengths of Babylonian lunar months dating back to the beginning of Nabonassar's reign must have been available. To convert Babylonian dates successfully into Egyptian dates, it would have been necessary to know for each single lunar month whether it had been either twenty-nine or thirty days long, as determined by observation. An error of one day in a single month would throw off all the subsequent dates by one day. Since Ptolemy's Babylonian observations, presented in Greco-Egyptian garb, have all been verified, the transmission must have been flawless. Meticulous cuneiform records of the required information do in fact survive, albeit in

16. On Ptolemy, see Toomer (1975).

17. See Aaboe (1974), Neugebauer (1975, vol. 1), Pedersen (1987), and Toomer (1988).

18. On Hipparchus, see Toomer (1978).

19. A Greek papyrus fragment from Roman Egypt identified by Neugebauer (1988) has recently added a new dimension to the study of the transmission of astronomical knowledge from Babylon to the Greek world. It contains Babylonian astronomical tables concerning the numerical analysis of lunar motion. This fragment brings Hipparchus out of isolation. One now senses a larger tradition. No dates are preserved in the text, but one would expect them to have been Egyptian civil dates, even when referring to lunar months.

fragmentary form, in the cuneiform Diaries.[20] It must have been relatively simple to derive from these Diaries the historical sequence of twenty-nine and thirty day lunar months for Babylon. There are about 7500 lunar months from the eighth to the second century BCE. The long list could be conveniently subdivided by king and regnal year—or later by the year according to the Seleucid Era. It would suffice to provide, in two columns, the Egyptian month and day date corresponding to Day 1 of each Babylonian lunar month.[21] No such tool is preserved, but one like it must have existed. The Egyptian day number would remain the same after a thirty day lunar month and decrease by one after a twenty-nine day lunar month; after the five epagomenal days, it would drop by five. Egyptian dates for the other days of the Babylonian lunar months could easily be inferred from the list. If about sixty equivalences between Babylonian and Egyptian dates were inscribed on one page in two double columns, about 125 pages of text would be sufficient. It would certainly not be necessary to write out the Babylonian-Egyptian equivalences for each of the more than 200,000 days contained in the period in question. Since the papyrus roll was the standard writing vehicle at the time, distributing the text over several rolls would facilitate consulting the list. Once it was decided to begin the list with Year 1 of Nabonassar, it would be natural to add up the totals of regnal years for each reign,[22] with the Era of Nabonassar as result.

This process of conversion can only be reconstructed hypothetically, but its accuracy is guaranteed. Computation confirms that astronomical events that Ptolemy says were observed at Babylon occurred on the Egyptian day and hour he says they did, as has long been known.

This possible scenario makes the Canon as much Ptolemy's work as a list of rulers compiled from various sources in a modern textbook can be considered the work of that book's author. The Canon just happens to be preserved in Ptolemy's *Handy Tables* in the layout in which Ptolemy chose to present it.

20. For the designation "Diaries," see the standard classification of Babylonian astronomical texts by Sachs (1948). For the texts themselves, see Sachs and Hunger (1988–89). On Hipparchus's use of the information contained in the Diaries, see Toomer (1988, 358–60).

21. Since the Babylonian day lasts from sunset to sunset and the Egyptian day from sunrise to sunrise, the Babylonian and Egyptian dates would only overlap for the time of daylight.

22. It may be assumed that the Egyptian wandering years counted from 26 February 747 BCE are not just artificially retro-calculated, but correspond to historical reality. On this matter, see Depuydt (1995a).