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Astronomical Diaries and Related Texts from Babylonia. By Abraham Sachs. Completed and Edited by Hermann Hunger. Wien: Verlag der Österreichischen Akademie der Wissenschaften. *Vol. 1. Diaries from 652 B.C. to 262 B.C.* 1988. Pp. 377 + 69 plates. *Vol. 2. Diaries from 261 B.C. to 165 B.C.* 1989. Pp. 499 + 96 plates.

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Before the 1880's hardly anything substantial was known of Mesopotamian astronomy aside from thirteen reports of observations made in Babylon between 721 B.C.E. and 229 B.C.E. quoted in Ptolemy's *Almagest.* Then, through the researches of the Jesuit scholars J.N. Strassmaier, J. Epping, and later F.X. Kugler, the recovery of the highly developed mathematical astronomy of Seleucid and Parthian Babylonia began. As early as 1900, Kugler had made the dramatic discovery that Hipparchus' (and hence Ptolemy's) lunar theory was founded on numerical parameters taken from Babylonian predictive schemes (Kugler 1900). Neugebauer's comprehensive edition (Neugebauer 1955) made practically the whole corpus of the tablets of mathematical astronomy from the astronomical archives of Babylon and Uruk (the so-called 'ACT texts') available for study, so that by now we have a fairly good understanding of the internal structure of the schemes represented by these texts.

Epping and Kugler also published a modest number of non-mathematical astronomical tablets ('NMAT texts'), now known to have come from the archive in Babylon.[1] But it was A. Sachs's study and classification of these texts (Sachs 1948) that really opened the way to the study of Babylonian observational astronomy. Sachs demonstrated that the NMAT texts then known fell almost entirely into five well-defined categories according to their format and contents: Diaries, Excerpts, Goal-Year Texts, Almanacs, and Normal-Star Almanacs. During the 1950's Sachs's investigations at the British Museum led to the discovery of well over a thousand new texts, an enormous expansion of the corpus that, wonderfully, necessitated only a few minor improvements to his classification. As a first step in the ambitious project of editing the NMAT texts, Sachs published a large

[1] Similar records were kept at Uruk, but so far only one Diary from Uruk (Text no. -463) has been identified.

collection of hand copies of tablets expertly drawn by T.G. Pinches about the turn of the century, prefaced by a substantial catalogue of the known texts (Pinches-Sachs 1955). Thereafter he concentrated his efforts on editing the Diaries, and by his death in 1983 he had done much of the philological and astronomical work. At Sachs's request, H. Hunger assumed the still considerable task of completing the edition, and has been carrying it out with impressive efficiency, albeit sacrificing most of the astronomical commentary with which Sachs had hoped to furnish his edition.

The two volumes published so far take us somewhat less than half way through the known Diaries. In the first, Hunger presents a useful survey of the structure, contents, and terminology of the Diary texts; a comprehensive glossary and indexes are promised for the final volume. The edition itself consists of transcriptions of the texts with facing English translations and brief notes (mostly concerning philological points and the dating of the texts). This would not be the place for an evaluation of the philological aspect of the edition, even were this reviewer competent to make one. From the point of view of a non-Assyriologist historian of astronomy, the translations clearly make the contents of the Diaries accessible for study, although it has to be admitted that extracting the information that one wants from the texts can still be laborious. In this review, I will try to outline the character of these texts, their significance for the history of ancient science (both Babylonian and Greek), and some of the possible lines of study that their publication may encourage.

The Diaries are far and away the most important class of NMAT texts. As semiannual records of astronomical and meteorological observations, they are the nearest thing that we have to immediate reports of observation. They are also the texts that exist in by far the greater number (more than 1200 fragments) and over the longest period: the earliest known Diary dates from 652 B.C.E.; the latest, from about 50 B.C.E. The fragments range from small bits to a few substantial pieces of tablets with several months well preserved. Although by its very nature the archive of Diaries must once have been a more or less continuous record covering at least six centuries, the chronological distribution among the surviving texts is very uneven, with the majority of years after 392 B.C.E. represented by at least one fragment, but only six texts for the earlier period. What these records are like can be seen at a glance from the following entries for month VII of the year Seleucid Era 114 (198/197 B.C.E.):[2]

Year 144, kings Antiochus and his son Antiochus, month VII, which followed a 'full' month of 30 days.

1st ...° [i.e. equatorial time-degrees] from sunset to moonset. The moon was bright, with earthshine, the interval was measured; very overcast.

2nd Night: very overcast. Day: very overcast.

[2] Text no. -197. I have rephrased and relineated the entries for brevity and clarity, and certain restorations of the text are not marked. Ellipses indicated unrestorable lost text.

3rd Night: moon was ... behind θ Ophiuchi.
6th Beginning of night: moon 2/3 cubit behind β Capricorni.
7th Beginning of night: moon 1 cubit in front of γ Capricorni.
8th Night ....
12th Beginning of night: moon 6 cubits below β Arietis and 1/2 cubit back to west.
13° 30' from moonset to sunrise, measured.
Saturn's first appearance in Libra; 15° from its rising to sunrise, hence ideal first appearance was on the 10th.
13th ...moonrise to sunset...clouds, I did not watch...2°...' from sunrise to moonset; clouds, I did not watch.
14th Night,...° from sunset to moonrise; clouds I did not watch; gusty wind.
Last part of night: moon 1/2 cubit in front of α Tauri.
15th Last part of night: moon 1/2 cubit below ζ Tauri and 1/2 cubit to...
Day: very overcast.
16th Night: very overcast.
Last part of night: moon 1 cubit 8 fingers above γ Geminorum.
Day: very overcast.
17th Night: very overcast.
Last part of night: moon 5 cubits below α Geminorum and 1/2 cubit back to the west.
Day: very overcast
18th Night: very overcast, rain.
19th Last part of night: moon 1 cubit in front of ϵ Leonis. Mercury's first appearance in the east in Libra, 3 1/2 cubits behind Saturn to the east; it was bright; 16° from Mercury's rising to sunrise, hence ideal first appearance was on the 17th.
20th Last part of night: Moon 6 fingers below α Leonis, having passed a little to the east.
21st Last part of night: moon 1 cubit in front of Mars to the west, and 1 cubit in front of θ Leonis.
22nd Last part of night: moon 1 cubit in front of β Virginis.
Last part of night: Mars 4 1/2 cubits below θ Leonis.
23rd Last part of night: moon 2 1/2 cubits in front of γ Virginis.
24th Last part of night: moon 2 1/2 cubits in front of α Virginis.
25th Last part of night: Mercury 1/2 cubit above α Librae.
26th Last part of night: moon 2 cubits in front of α Librae, and 2 cubits in front of Mercury, and 1 1/2 cubits below Saturn, having passed 1/2 cubit to the east.
27th 12° from moonrise to sunrise, measured.
29th Last part of night: Mercury 3 cubits below β Librae.
That month, the equivalent for 1 shekel of wrought silver was: 4 pan

of barley; 1 kur 2 pan 3 sut of dates; 1 kur 2 pan 3 sut of mustard; 2 pan 5 sut of cress; 1 pan of sesame; 4 minas of wool, which was given in the land.

At that time, Jupiter was in Aquarius; around the 17th, Mercury's first appearance in the east in Libra; Around the 10th, Saturn's first appearance in the east in Libra; Mars was in Leo; Venus, which had set, was not visible.

That month, the river level rose from the 10th to the 15th 1 cubit, total gauge 26; it receded from the 15th to the 23rd 1/2 cubit, total gauge 29; it rose from the 24th to the end of the month 1/2 cubit, total gauge 23.

The main body of entries for each month is the night-by-night and day-by-day record of certain astronomical events or (bad) weather. Briefly put, the events watched for were, for the moon and planets, the first and last visibilities, sunset ('acronychal') rising and (for the moon only) sunrise setting near opposition, eclipses, stations, and passages by a standard set of thirty 'Normal Stars'. Each month concludes with a list of current prices for commodities, a summary of the planetary positions, data on the river level, and, often, reports of events of local or national interest. The format and contents of the Diaries remained remarkably stable over the interval of 600 years represented in our texts.

The Diaries and other NMAT texts tell us practically nothing about the milieu in which they were written. Other documents from the Parthian period indicate that at that time the observers at Babylon were trained specialists employed by the temple assembly, and that the same people compiled NMAT and ACT tablets; the colophons of the latter often identify their authors as 'scribes of Enuma-Anu-Enlil', after the great Babylonian compendium of celestial omens.[3] Much earlier, during the first half of the seventh century, Babylon was one of the several Babylonian and Assyrian centers that communicated to the Assyrian kings Esarhaddon and Assurbanipal observations and interpretations of astronomical omens, i.e., such events as first and last visibilities, stations, and eclipses (Parpola 1970-1983). The evidence we possess suggests that the original purpose of continuous observation was to watch for celestial omens, and that the systematic record-keeping served at least in part to make possible the prediction of likely dates for omens. The astronomers of the Assyrian correspondence were able to predict eclipse possibilities and some other phenomena with some success; likewise the earliest Diaries already contain reports of phenomena that were anticipated but could not be observed because of weather conditions ('I did not watch'), while some events (e.g., solstices and equinoxes) were *always* computed according to a fixed scheme.

Prediction was at first made possible by the discovery of recurrence periods. For example, lunar eclipses recur with nearly the same magnitudes after eighteen years, and with nearly the same longitudes after nineteen years; and for each

[3] See the references in vol. 1, 11n2.

planet there are periods of whole numbers of years after which the patterns of phases and Normal Star passages repeat. Excerpt texts, in which phenomena of a specific kind were extracted from Diaries of successive years, would have been useful for discovering and applying recurrence periods. The most noteworthy of the Excerpts are organized series of eclipse records, which extend back to the middle of the eight century—significantly, the same date from which Ptolemy tells us that eclipse observations began to be available. During the Seleucid period, if not earlier, the more complex Goal-Year texts were compiled by extracting observations of phases and Normal Star passages for each of the planets, one recurrence period before a 'goal year'. These perhaps provided the raw data for the Normal Star Almanacs, which laid out predictions of the same phenomena for the year in question. The process then comes full circle, since the Normal-Star Almanacs look as if they were the observers' guides and the source of the predicted phenomena in the Diaries. These interrelationships between the Diaries, Goal-Year Texts, and Normal-Star Almanacs are, however, only conjectural; a thorough concordance of the data in the preserved texts still has to be carried out.

The role of the Diaries in the development of mathematical astronomy is less obvious. Reading the Diaries and the NMAT texts directly dependent on them, one is immediately struck by the manner in which the positions of the heavenly bodies are reported. The longitudes of the planets at their reported phases are specified only by the zodiacal constellation or, in texts after about 500 B.C.E., by the schematic zodiacal sign in which the planet stands. Normal Star passages of moon and planets are described more precisely, but the distances and directions from the stars follow conventions (as yet not fully understood by modern scholars) that would make conversion into ecliptic coordinates difficult. Degree measure is used in the Diaries only for the intervals between risings and settings, where it is essentially a unit of *time*. By contrast, the mathematical predictive schemes of the ACT texts operate with longitudes in degrees and sexagesimal fractions of degrees. Some of the most promising recent work on the ACT material has concentrated on the problem of how the precise numerical schemes could have been developed on the basis of the observational record that we know was available. This is a speculative pursuit, since we possess no texts that describe the relationship between observations and theory in Babylonian astronomy, such as we have for its Greek counterpart. What we do have are the mathematical structures of the schemes themselves, and a few so-called 'atypical' texts from the fifth and fourth centuries, when the schemes seem to have evolved.

A significant advance was made by A. Aaboe, who has discovered a simple and plausible course by which the characteristic structure of the planetary schemes known as System A arose (Aaboe 1980); the same principles have been extended to the System B planetary schemes and some parts of the lunar schemes. The essence of the argument is: (1) that the distribution of occurrences of any particular phase of a given planet is conspicuously not uniform over the ecliptic; (2) that a pattern of relative frequencies can be found by counting occurrences of the phase in arbitrarily chosen zones of the ecliptic over an interval of years; and (3) that this pattern can then be reproduced by an arithmetical predictive scheme in which these zones and the corresponding counts are almost the only empirical component. I am confident that this reconstruction is essentially correct; nevertheless there remain many details to clear up. For example, the 'statistical' method of measuring distribution presumes a continuous record of observed occurrences of the phase in question, whereas the Diaries show that observation was often hindered by clouds and bad weather; how, then, were the gaps filled? It remains truly astonishing that the Babylonian astronomers succeeded in deriving very accurate quantitative schemes from the records of a program of observation that had been designed centuries earlier and with a wholly different purpose in mind.

Yet another unsettled question is what the ACT schemes were used for, and whether they are reflected in any way in the Diaries and other NMAT texts. The simpler recurrence-period techniques of the Goal-Year texts sufficed to make the predictions of dates of phases and Normal Star passages that we find in the Normal-Star Almanacs and Diaries. On the other hand, the ACT schemes could not predict Normal Star passages, while the precise longitudes of phases that they did generate are not to be found in NMAT texts. But there remains another kind of data frequently reported in the later Diaries and above all in the class of texts called simply Almanacs, and that, so far as we know, only the ACT schemes could furnish: the dates when each planet crossed into a new zodiacal sign. The possible dependence of the Almanacs on ACT methods deserves all the more to be studied, since certain Greco-Egyptian tables with marked affinities to the Almanacs are known to have been computed according to ACT schemes (van der Waerden 1972).

Much has been learned about the ties connecting Greek and Babylonian astronomy since Kugler's discovery of the common parameters in Hipparchian and Babylonian lunar theory. By scrutiny of the fragmentary testimonia (especially in Ptolemy's *Almagest*) for Hipparchus' writings, early Sanskrit astronomical works derived from lost Greek treatises, and, increasingly, Greek and Demotic papyri of the Roman period, it is now apparent that an extensive transmission of Babylonian astronomy into Greek occurred about the second century B.C.E. (Jones 1992). An important part of Hipparchus' theoretical work in lunar and solar theory consisted of confirming parameters in the ACT schemes and applying them to kinematic geometrical models. He even depended on the ACT schemes to calculate solar and lunar positions; indeed, the methods of predictive astronomy attested in the papyri continue to be predominantly adaptions of Babylonian arithmetical schemes until well after Ptolemy.

Historians have from time to time tried to account for this transmission by identifying specific personal channels: particular Greeks who went to Babylon, or particular Babylonians who might have written handbooks of astronomy in Greek. But it is not easy to see how a narrow 'scholarly' transmission could have brought about the conditions revealed in the papyri of the Roman period, that is, a wide dissemination of the complex Bablyonian predictive schemes among provincial astrologers. I wonder whether these astrologers were not rather the direct heirs of a continuous practical tradition that began with expatriate Babylonian scribes. So far as we can tell, the technical knowledge that passed over to the Greek world was not accompanied by any information about the observational basis of the schemes.

But the Babylonian observation reports quoted by Ptolemy must have a different story. Whatever astronomical lore itinerant 'Chaldean' astrologers may have possessed, they certainly did not carry about with them extensive and detailed observational records. Ptolemy tells us explicitly that he had access to more or less continuous series of eclipse records starting from the beginning of the reign of King Nabonassar (747 B.C.E.); and it is clear that these observations were already available to Hipparchus. Ptolemy also had Babylonian planetary observations from the third century, including both phases and Normal Star passages (he quotes three of the latter kind)—again, it would seem, through the medium of an edition by Hipparchus. Hipparchus himself may have fetched at least some of these observations from the Babylon archive (Toomer 1988); but details of the reports, as given by Ptolemy, also suggest the possibility that they were obtained and translated by more than one person, and perhaps from more than one kind of source. The three Babylonian planetary observations in the *Almagest* look like essentially exact and unaltered translations of Diary entries, even preserving the dating according to Babylonian months (in Macedonian disguise) and the Seleucid ('Chaldean') Era. The eclipse reports, on the other hand, have clearly been edited: most are dated according to Babylonian regnal years, but in the Egyptian calendar, while the latest three are curiously dated according to Athenian archonships and Athenian month names, without specifying the exact day. It is also noteworthy that the times of the eclipses are reported in seasonal hours in the *Almagest,* whereas Diary reports typically give time-degrees counting from sunset. Thus, while there is little doubt that the Diaries were the ultimate source of the eclipse observations used by Hipparchus and Ptolemy, we have to suppose considerable intermediary editing, the details of which are still poorly understood. It would by helpful if we could compare Ptolemy's versions with Diary entries for the same eclipses. Unfortunately, only one of Ptolemy's Babylonian eclipses has so far been found in a cuneiform document, and not a standard NMAT text at that; there are significant discrepancies between these reports.

Lastly, there is the still more enigmatic topic of the influence that the Babylonian observational program may have had on Greek astronomical observations. Ptolemy cites two series of observations made in Hellenistic Egypt during the third century B.C.E.: a set of lunar occultations and passages near fixed stars observed by Timocharis between 295 and 272 B.C.E., and eight fixed-star passages of Mercury, Mars, and Jupiter observed by an unnamed astronomer between 272 and 241 B.C.E. The purpose of these observations is not clear. They bear some resemblance to the Babylonian reports of Normal Star passages (in the second set, the stars are in fact all Normal Stars), although the metrological conventions are not Babylonian. Much the same could be said for the much later observations of Agrippa and Menelaus (c. 100 C.E.) and Theon (c. 130 C.E.) that Ptolemy quotes in the *Almagest.* It is tempting, albeit speculative, to see in these reports the isolated remains of several prolonged series of night-by-night observations that were modelled at some remove on Babylonian practices.

These are of course mere guesses. But of the fundamental significance of the observations of the Babylonian scribes there can be no question: they were the tap-root of ancient mathematical astronomy. The swift publication of reliable editions of the Diaries and (let us hope) of remaining NMAT texts promises to lay open an enormous new field of research.

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Pleasure, Knowledge, and Being: An Analysis of Plato's Philebus. By Cynthia Hampton. Albany: State University of New York Press, 1990. Pp. ix + 144. $44.50 (cloth), $14.95 (paper).

Pamela M. Huby

Professor Hampton, unlike most of her predecessors, holds the attractive view that the *Philebus* has a unified structure which she tries to explain by a careful study of the context in which topics and arguments appear, wanting to find 'the knots which bring the major threads together'. She argues that the classifications of pleasure and knowledge and their varieties are made on ontological grounds,