CUNEIFORM MONOGRAPHS 18

MESOPOTAMIAN PLANETARY ASTRONOMY-ASTROLOGY

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3.1.2 Period Schemes

These are those parts of the cuneiform astrological-astronomical texts that have, for the most part, been quoted out of context in an effort to demonstrate the existence of a predictive astronomy before the late period (see n267). They describe "ideal" periods for celestial phenomena based on the nearest "round" numbers (of years, months, days, or double-hours) to the true periods. However, these did not represent inaccurate assessments of the true periods for recurring celestial events, but had divinatory purposes. I propose that their aim was to provide a means of judging when a celestial body was behaving according to the ideal, and when it was not. The evidence is that the former was considered propitious, the latter not. The ideal period was a category *which permitted the times of events to be interpreted. The interpretations given to correspondence and non-correspondence with the ideal formed part of the* code, *and the means by which the ideal periods were elaborated into schemes which modelled other celestial phenomena were made possible through the application of* rules. *This is a new description of these kinds of text, and is important in the definition of the EAE Paradigm proposed here.*

A period of 360 days, comprising 12 months of 30 days each, was assigned by the Mesopotamians to the year in days and months at least by the third millennium BC. This period was used extensively in administrative circles since it simplified those transactions with temporal components.[287] By the OB period, at least, a ratio of 2: 1 for the longest night to the shortest accompanied the 360-day year. The longest night was located on the 15th of month IX, the shortest on the 15th of month III. The equinoxes were dated to the 15th of months XII and VI. This complete scheme I entitle the "*ideal year*". See App.1 §§8 & 11.

Also in the third millennium the *eššešu* and other lunar "cultic" festivals were celebrated on certain days of the lunar cycle which were related to those times when the Moon was *ideally* new, half-waxed, full, half-waned, about to disappear and absent (App.1 §3). This scheme is known here as the "*ideal month*". It is attested, for example, in the second "divi-

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[287] For details of the earliest attestations of the 360-day, 12-month "administrative year" see Englund (1988). For a study of the rôle the 360-day year played in the development of units used for measuring celestial distances and times see Brown *CAJ* forthcoming. An actual Mesopotamian year, sometimes called the "cultic" year, was made up of 12 lunations, each lasting either 29 or 30 days each. Since this fell short of a solar year, every three years or so a 13-month year was required to keep the lunar year and solar year more or less synchronised. See below.

sion" *pirsu* of i.NAM.giš.ḫur.an.ki.a. Lines IIi1–9 (K2164+[288]) describe critical days in the month including the 1st, the 7th, the 14th, 15th, 21st, 27th, and 28th. In *Iqqur īpuš* §67: 1 and §68: 1 omens concerned with the Moon's visibility on the 14th, 15th and the 30th are found.

In EAE 14, a scheme describing the ideal periods of the Moon's visibility and invisibility at new Moon and at mid-month are presented. It is based on the "ideal year" and on a premise of the "ideal month" that on the 15th the Moon is visible all night. For nights n: 1–14 the length of the Moon's visibility after Sunset is thus calculated to be n/15 multiplied by the length of the night on the 15th derived from the "ideal year" scheme. For nights n: 16–30, the length of the Moon's invisibility after Sunset is (n-15)/15 multiplied by the length of the night of the 15th. The constants "40" and "3 45" used in this EAE 14 scheme[289] are also attested in OB coefficient lists (see App.1 §8) indicating that this, the "*ideal lunar visibility/invisibility interval*" scheme, is also of OB origin.

In Mul.Apin IIii43–iii 15, and in i.NAM.giš.ḫur.an.ki.a II r.1–24, related schemes are found. They are identical to each other and the same as the EAE 14 scheme except for three subtle changes. Firstly, the dates of the equinoxes and solstices have moved forward by one month to the 15th of *nisannu* (I).[290] Secondly, *ideal* acronychal rising (the last day when the Moon is still visible before Sunset) of the Moon has been located on the 14th, and not on the 15th. The 15th is thus *ideally* the first day the Moon is visible in the morning before Sunrise, hence the reference to both these days in i.NAM.giš.ḫur.an.ki.a IIi1–9, noted above. Thirdly, the length of the lunar visibility period at the beginning of the month has been made a proportion of the length of the night at the beginning of the month, and not of the length of night in the middle of the month, as in EAE 14. However, the Mul.Apin and i.NAM.giš.ḫur.an.ki.a scheme is *not* a more accurate reproduction of actual lunar behaviour. It was no more empirically based than was the EAE 14 scheme. Both were *elaborations* based on "ideal years" and "ideal months". It is inconceivable that they were the best estimates of the periods of these celestial phenomena made by the Mesopotamians. It would not have taken long to recognise that about half of all months lasted only 29 days, for example! The numbers 360, 30 and 2: 1 are simple, or "round", particularly in the prevailing number-base used for calculations – base 60. Both lunar visibility/invisibility schemes were simply extensions of these simple numbers – ideal *hypothetical deductions* whose purpose was not to reproduce reality, but to widen the applicability of the EAE Paradigm. More on the evidence for this in §3.2.2.

EAE 63, the "Venus tablet of Ammiṣaduqa", which apparently includes observational material from the OB period, also includes in section II a scheme for the periods of time for

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[288] Livingstone *MMEW* 22f.

[289] In the Nippur tradition of EAE 14, 3;45 UŠ is the length of first lunar visibility derived from a slight modification of the simple rule outlined above. See Al-Rawi & George (1991) Table A p55f.

[290] This is not particularly significant. It does appear from limited evidence that in the OB period the vernal equinox was conventionally placed by the Scholars in month XII, and that by the NA/NB periods it was commonly located in month I. It is possible that this change was a consequence of the gradual slipping apart of the seasons and the stars known as the "precession of the equinoxes", but it is equally possible that in the later period it was only a new convention which moved the date. Because 12 lunar months are 11 days shorter than a solar year, even if in the OB period the calendar was organised such that the vernal equinox *mostly* occurred in month XII, approximately one year in three it would still occur in month I. It is only in the "ideal year" that the date of the equinox is fixed to one month. It is entirely probable that both conventions existed side by side in the OB period. Certainly, they existed simultaneously in the later period given the Scholars' use of both EAE 14 and Mul.Apin in the late NA period. The use of a vernal equinox in month XII might suggest an OB origin, but the use of the vernal equinox in month I does not preclude one.

which the planet was visible and invisible (see App.1 §9). This scheme assigned 8 months and 5 days to the planet's visibility in the east and the west, 7 days to inferior conjunction, and 3 months to superior conjunction. This ideal scheme should be compared with the more accurate description in Ch.2.2.1, here. It remains unclear whether this period scheme for Venus dates from the same time as the observations in EAE 63 section I, though the name "Ninsianna" *is* used for Venus in both section II and in the section believed to contain observations from the reign of the OB king Ammiṣaduqa. It is known here as the "*ideal Venus*" scheme.

The evidence concerning the so-called "astrolabe" is outlined in detail in App.1 §§13, 16 and 17. I suggest there that it was an OB (or early MB) creation. Essentially the astrolabe was a scheme in which three stars, one lying in each star-path,[291] were meant *ideally* to rise heliacally in each of the 12 months of the "ideal year". In some examples of the genre, numbers corresponding to the lengths of the watches of the night accompanied the star names, and these numbers indicated that a 2: 1 ratio between the longest and the shortest night was used in the scheme. The "*ideal astrolabe*" was thus underpinned by the "ideal year". Significantly, the order of constellations and the dates of their ideal first appearances reappear in EAE 51, in commentaries on EAE 50, and in Mul.Apin Iii36 – iii12, once more attesting the interconnectedness of these texts. Horowitz (1998) 162–5 argues that the astrolabes fulfilled the rôle of a sidereal calendar, with the heliacal rising of some star marked by a *date* in the lunar calendar.[292] No days, only months, are noted in the astrolabes, however, and even in Mul.Apin Iii36–iii12 the days of heliacal rising are either the first of the month or multiples of five, more suggestive of an invented scheme than the record of particular observations. While certain seasonal events, harvesting and so forth, may have been marked by certain stars (App. 1 §1), I think it highly unlikely that the astrolabes served this "astronomical" purpose, though the residue of certain traditional seasonal-stellar associations may have filtered into them.[293] They were, instead, learned elaborations based only very loosely on observational reality with regard to the heavens, whose purpose was *not* to regulate the calendar, but to permit celestial diviners to *interpret* the occasion of a star's first appearance as good-boding if it corresponded with the scheme and ill-boding if it did not. More on this in §3.2.2.

An "*ideal seasonal hour*" scheme appears for the first time in late NA period texts (App.1 §31). It was very simply related to the ideal year and did not represent an improvement in the accuracy with which times were recorded. Seasonal hours are not attested in EAE to my knowledge, but the published fragment has recently been joined to another tablet which contains part of EAE 14. Seasonal hours were presumably not thought to have been particularly different in purpose to that of EAE 14. They are perhaps an example of those post-OB innovations, such as moving the vernal equinox to I 15, which still relied on the same basic premises found in EAE itself.

Mul.Apin (App.1 §30) is the best known cuneiform series in which period schemes are attested. Many of these appear at first sight to be substantial improvements on the schemes

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[291] The paths of Anu, Ellil and Ea – see *BPO*2 17–18 and Horowitz (1998) 252f.

[292] Op. cit. 164 "it is probable that the earliest "Astrolabes" were intended, in part at least, to help farmers determine the optimum dates for farming activities." I imagine that the farmers did not turn to the literate temple and palace employees to determine when and when not to sow, since clearly they had managed for millennia without such help.

[293] E.g. in *Astrolabe B* month II is said to be the month of the "turning of the soil" and was marked by the Pleiades. Was this a traditional association between the stars and an agricultural event?

just described, and the text has usually been considered "astronomical" – that is, different from EAE, and with a primary aim of regulating the luni-solar year (e.g. Chadwick, 1992, 18). I indicate below, however, that most of the period schemes attested in Mul.Apin are not substantially different from those attested in EAE, and that Mul.Apin contains material which is substantially older than the date assigned to its composition by Hunger & Pingree (1989). I suggest that it does *not* represent a significant improvement on the schemes of known OB date, and that Mul.Apin's aims are in no way distinct from those of EAE. Mul.Apin, as with all the pre-750 BC period schemes, falls well within the remit of the EAE Paradigm.

In its very first section (Ii1–ii35) Mul.Apin lists many more stars in each of the three star paths than are found in the astrolabes, and the planets are more clearly distinguished. However, mere "star ordering" is not "astronomy", so far as the modern usage of the term implies, regardless of the word's etymology (see n15). For that, the prediction of celestial phenomena must be intended.[294]

Many of the stars appear to be out of order in this list. This could have come about because the late copies of Mul.Apin, the only ones we have, are in some way "corrupt".[295] However, it may also be because the star lists were never intended accurately to reflect reality. Pingree suggests (*Mul.Apin* 139) that Jupiter was located at the end of the Ellil stars because of its "association" with Marduk and Nēbiru – a divinatory reason. On the other hand he argues that the four other planets were located at the end of the group of Anu-stars because the latter "lies more or less in the middle between the northern and southern extremes of the ecliptic". This observational reason is plausible, but does Jupiter's different location not demonstrate the precedence of divinatory thinking over "astronomical"? In general, Pingree's explanations for the schemes in Mul.Apin emphasise that which is closest to observational reality, and dismiss as corrupt those aspects which do not correspond with reality.[296] He wishes to interpret the text as an "astronomical compendium". Here it is interpreted as a text of the EAE Paradigm.

The dates of the heliacal rising of some stars are given in the following section, Iii36–iii12. I commented on these lines above in regard of the "ideal astrolabe". The dates given in Mul.Apin for these first appearances are not accurate. They were not the record of a series of observations, but were produced "artificially" while corresponding very broadly to reality. They could *not* have been used for precise prediction.

In Iiii13–33 a list of simultaneously rising and setting stars is given. Undoubtedly, an observational component was involved in the construction of this scheme. However, at the same time Mul.Apin includes the ideal proposition that a star rising heliacally in month n will rise acronychally in month n+6 (Iii42 – Iiii8). I call this the "*ideal acronychal rising*

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[294] I do not wish to press unduly for this definition of "astronomy", but I maintain that a difference in the understanding of the purpose of the material *was* intended by those modern students who described Mul.Apin and the like as "astronomical" and yet referred to EAE as "astrological" or "divinatory".

[295] By which is meant that the original texts *did* correspond to reality, but that as a consequence of copying errors, misreadings, and lacunae within texts, the later versions no longer do. Arguing for corruption as an explanation for the cruxes within these texts is tantamount to arguing for a loss of wisdom from the time when the text matched observation to the later period when it did not. This will not be argued here. To argue for a "loss of wisdom" is to prejudge the intention of these texts, I believe, and reflects the desire of the contemporary student to have the ancient scribes share his or her particular interests as to the purpose of texts concerned with the sky – namely the accurate mapping of the heavens in order to make possible the accurate prediction of phenomena , or "astronomy".

[296] Repeated in *BPO3* p29 2.

date" scheme. It also equates a sidereal year with 12 months, much as do the astrolabes. The list in Iiii34–48 is entirely derived from the list of dates of heliacal rising (Iii36–iii12).

In Iiii49–50 Mul.Apin states that the stars move by 1 UŠ (relative to the Sun) each day. Given that an UŠ is 1/360th of a revolution, this scheme implies that one full sidereal rotation, or year, would take 360 days. It is the "ideal year", once again.

In Iiv1–30 the *ziqpu* stars and their dates of culminating are mentioned. The use of culminating stars may represent an innovation of Mul.Apin itself or of the late MB period,[297] but once more the list appears not fully to correspond with reality. Pingree remarks (loc. cit. 141–2): "Assuming our identifications are correct, one would conclude that in *ziqpu* star lists, as elsewhere, tradition often determines content rather than a strict adherence to observed fact." It is precisely the existence of this "tradition" in texts formerly considered "astronomical" that is of great interest. The fact that so many anomalies and astronomical errors occur, errors which could so easily have been remedied by observing the sky, suggests to me that the purpose of these texts was not accurately to record celestial phenomena, and certainly not to make them accurately predictable.

In Iiv31–IIi8 the ecliptic constellations are listed, and the seven planets that move through them are named. While the ecliptic constellations are not named together in texts thus far attested from the OB period, many of them are noted individually and it could hardly be considered "astronomical" that they were so listed in Mul.Apin. Since many EAE omens pertain to the locations of the planets in constellations, listing them in Mul.Apin clearly had a divinatory purpose *as well*, perhaps *alone*.

In IIi9–21 a model concerning the movement of the Sun is presented. According to this "*ideal solar movement*" scheme the Sun rises at its most northerly point at the ideal summer solstice of IV/15. 90 days later the Sun appears directly in the east. 90 days after this it rises at its most southerly point, and the scheme repeats after 360 days. The OB "ideal year" is invoked yet again, for 40 ninda are said to be the daily change in the Sun. This is 1/180th of the change in the length of the day between solstices (120 UŠ, 8 hours, or 4 mina by water clock units[298]) if and only if the longest day is *twice* the length of the shortest. It is possible that in this section of Mul.Apin an equation was being made between the solstices and the most northerly or southerly positions of the Sun in the morning. However, it is the ideal *dates* for these events[299] (a date which can vary by a month or more either side of the 15th of months IV or X) which are actually correlated to the rising position of the Sun. This is neither accurate with respect to the lunar year nor to the solar year, and could not have been used as a basis for accurate predictions. However, the scheme was perfect from the point of view of permitting Scholars to await the solstice, and then to derive significance from its date in relation to the ideal date of its occurrence.

In IIi22–24 of Mul.Apin it is remarked that the above scheme can be used to assess "how many days are in excess", by which is meant how many days over 12 lunar months the year(s) has lasted. This is an intercalation scheme. It suggests that the extent to which the

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[297] See Brown *CAJ* forthcoming on the antiquity of celestial timing and the possible rôle of *ziqpu* stars in the development of celestial distance units.

[298] See Brown, Fermor & Walker (1999).

[299] The text describes the rising of $^{\text{mul}}$kak.si.sá at the solstice, so in theory the sidereal and equinoctial years were also being correlated. In fact in Iii42 several stars are said to rise on the ideal date of the summer solstice, which in reality rise on different dates. It is most likely that this constellation was related to the summer solstice simply because the ideal date for the appearance of *both* was IV/15.

ideal year (as exemplified by the "ideal solar movement" scheme) exceeded a real year was judged to an accuracy of a day. Apparently the author(s) of Mul.Apin were quite aware that the ideal schemes did not correspond with reality. These lines make it absolutely clear that the exponents of the wisdom of Mul.Apin were not making primitive, inaccurate, or naïve estimates of the periods of celestial phenomena, but were fully aware that a real year was not 360 days long, and so forth. Why they persisted in designating the length of the year by this number suggests to me that what was attractively "round" from an administrative point of had remained useful from a divinatory one.

In IIi44–67 schemes concerning the lengths of the appearances and disappearances of the superior and inferior planets are presented. Pingree loc. cit. 149 calls them "crude...when compared with the values found in *ACT*". This misrepresents their purpose, I suggest. A brief scrutiny of the numbers will reveal that they are unusually "round" (e.g. *Ju*: 1 year, 1y+20d, 1y+1m; *Sa*: 1y, 1y+20d; *Ma*: 1y, 1y+6m, 1y+10m, 2y, 2m, 3m+10d, 6m+20d; *Ve*: 9m, 1m, 1m+15d, 2m, 1d, 3d, 7d, 14d; *Me*: 7d, 14d, 21d, 1m, 1m+15d). Relationships exist between the various numbers – the first three periods for Mercury are multiples of 7. The Mars invisibility period of 6m+20d is double the period 3m+10d, just as the visibility period of 2y is double 1y, for example. Clearly, many of these numbers were not derived from observation, but from mathematical manipulation. Some, at best, are distantly related to observation. There is nothing in this section or elsewhere that suggests that these figures would ever have been used to predict the occurrence of celestial phenomena. Comparing these figures with those derived from later schemes whose authors knew that some phenomena could be predicted accurately, does not compare texts the purposes of which are the same. I suggest that these figures for planetary periods provided useful *divinatory* material, and were derived with techniques considered *legitimate* by diviners – learned techniques of number play (see §3.2.1). They were schemes of "*ideal planetary visibility/invisibility*" which, as with the other schemes, only broadly corresponded to reality. Their purpose was, I suggest, to provide the Scholars with figures against which real phenomena could be judged. It is worth remarking that the visibility and invisibility periods of Venus are "cruder" than those in EAE 63 (see above), and are partially repeated in EAE 64.[300] The same invisibility period for Saturn, and the same periods for Mercury are found in EAE 56[301].

In Mul.Apin IIGapA1–7 a scheme relating the star path into which the Sun rises with the months of the year and the seasons is provided. Yet again it depends on the ideal year and the ideal solar movement scheme.

IIGapA8–9 presents the "*Pleiaden-Schaltregel*"[302] for intercalation:

> "If the Moon is in conjunction with the Pleiades on the 1st of *nisannu* (I), there is no need to intercalate a month. If the Moon is in conjunction with the Pleiades on the 3rd of *nisannu*, this year is a leap year."

The Moon moves about 13° per day, so in essence this scheme implies that if the lunar calendar has fallen behind the stellar by some 26° it is time to add in an extra month. It is immensely imprecise. Pingree loc. cit. 152 notes that in order to make sense of it, "to be in

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[300] *BPO*3 p15 and 244f, K2346: 21–2, group F (approx. EAE 64).

[301] Largement (1957) §XVIII–XIX.

[302] So named by Schaumberger *SSB* Erg.III 340f.

conjunction with" (*šitqulu*) must really mean "to be the closest to". This is unsatisfactory, considering that several other terms are used to describe the mere proximity of the Moon to constellations, and *šitqulu* (Gt *šaqālu*) literally means "to be equally weighted" and is regularly used in the Reports and Letters to mean "opposition" or "conjunction". I suggest, therefore, that the scheme was not derived from observation, but was derived directly from the simple proposition found in Mul.Apin IIGapA10–ii17 that the luni-solar year was kept synchronised by adding one month every three years – which I term the "*ideal intercalation*" scheme. This is equivalent to saying that a month should be added when the lunar calendar has fallen behind the sidereal year by 30°, since one month is 1/12th of the (ideal) year during which time the stars' rising points move (ideally) 1/12th of 360°, or 30°. Given the Moon's daily movement of about 13°,[303] the best estimate for the day of the month after the 1st *after which* it was perceived to have moved about 30° is the 3rd. Fewer than two days and the Moon would have moved less then c. 26°, more than three and it would have moved too far. Only on the 3rd day after the 1st will the Moon have moved c.30°, according to this line of thinking, and hence the "Pleiaden-Schaltregel", I argue. We should not try to see in the "Pleiaden-Schaltregel" any more precise an attempt to regulate the calendar than the *addition of one month in every three years.* It is an ideal scheme derived by learned methods fully comparable to those which elaborated other aspects of the EAE Paradigm.[304] It is not a model of planetary movement based on empirical evidence, it is a divinatory device derived from a well known rule of thumb. Its divinatory purpose will be mentioned shortly.

In Mul.Apin IIii11–17 (where this rule of thumb is noted explicitly) it is remarked that the "correction for the year" is 10 days (i.e. one-third of an ideal month) making the ideal intercalated year 370 days long. Again this is wildly inaccurate, and could not possibly

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[303] Derived from 1/30th of [360° (one month's revolution) + 30° (the additional movement of the earth in that same month)].

[304] Hunger & Reiner (1975) published another intercalation scheme attested in texts from Nineveh. This scheme only stipulates the celestial configuration that shows that no intercalation is necessary, stating that if the configuration does not occur on the stipulated date "(the year) is left behind" *ezbet* (op.cit. p24). The configuration in question is the conjunction of the Moon and the Pleiades (igi-*šunūtima ištaqlu* "they are seen balanced with each other") on day 27–2n of month n, for n: 1–12. It implies that, according to the ideal, the Moon and Pleiades are in conjunction on day 3 of month XII, and on day 25 of month I, for example. Their analysis (op.cit. 26–28) shows that each line of this scheme implies a different date for the beginning of the year, *and* that the vernal equinox fell before the 1st of *nisannu* (I) (OB?). Also, the authors note the existence of text *ACh.* 2Supp.19: 22f where yet another intercalation rule is found. This latter states that the year does not require intercalation if the Moon and Pleiades are in conjunction on the 3rd of *nisannu*. This is in complete contradiction to the "Pleiaden-Schaltregel". Hunger & Reiner write: "The differences between the texts suggest that no conclusion about the time of origin of any one of these rules can be drawn from their contents. It seems as if there were different attempts to solve the problem of intercalation rules."

I suggest that the discrepancy between these attempts shows that their intention was never to regulate the luni-solar calendar accurately, but simply to provide ideal scenarios against which observed situations could be compared for ominous significance. I have shown how the "Pleiaden-Schaltregel" could have been derived from the most simple intercalation scheme of all, the adding of one month every three years. The Hunger & Reiner (1975) scheme could have been similarly derived. According to the "ideal year" scheme the location of the Moon on day m of month n is 30° behind the location of the Moon on day m of month n+1. On day m+2 (48 hrs later) it will have ideally advanced by c.26° and will continue to advance a little since it is visible for longer than it was on day m. By day m+3 it will have moved by c.39°. The scheme supposes, then, that the Moon will be at the same location in month n+1 on day m, as it was on day m+2 in month n. This is the entire basis of the scheme. It is not really an intercalation rule at all, but a neat pattern derived from equating the monthly movement of the Moon with twice its daily movement. If an equation between monthly and daily movement had to be made, the factor of two would be the best to choose, assuming that one had only whole numbers to choose from. This is the essential point. The scheme is based on simple "round" numbers, just as is the case in all the other ideal schemes.

have been believed to describe the length of a solar year accurately. It was, instead, the consequence of a mathematical elaboration on what had long since been recognised in Mesopotamia, that one additional month every three years kept the lunar calendar and the seasons pretty much aligned.[305] (The evidence is simply that because some at least of the oldest month names described seasonal activities, the lunar and solar calendars *must have been* kept synchronised – see App.1 §4.) This well-known astronomical fact was simply worked into a scheme in Mul.Apin which had a divinatory purpose – the "ideal year".

The final period schemes in Mul.Apin pertain to the time intervals for changes in the lengths of shadows at the solstices and equinoxes (IIii21–42) and the above mentioned "ideal lunar visibility/invisibility" scheme (IIii43–iii15). As Neugebauer *HAMA* 544–5 showed, the time intervals in the shadows-section were computed according to tables of reciprocals. They bear little relationship to observation and could not have been used to time anything even remotely accurately. The 360 days of the "ideal year" are implicit in all the accompanying calculations. Pingree, in *Mul.Apin* p153, suggests that since the ratios of the times for the occurrence of a shadow of one cubit in length at the solstices is 3: 2, this provides evidence that this, more accurate, ratio between the lengths of the longest and shortest nights was known to Mul.Apin's authors. This is unlikely, however, as the 2: 1 ratio is otherwise used throughout the series, and because it is also now apparent that what was believed to have been the earliest attestation of this ratio in i.NAM.giš.ḫur.an.ki.a II26–7, in fact turns out to be no more than the "correction for a day" quoted in Mul.Apin IIii14.[306] The 2: 1 ratio is thus the *only* ratio of maximum: minimum night lengths known in texts composed in the period before c. 750 BC. Despite certain attempts to account for the inaccuracies in this 2: 1 ratio in terms of the timing apparatus used,[307] it is apparent that in many, if not all the known examples, the ratio was indeed understood to be in terms of *time*.[308] The use of this very inaccurate ratio in Mul.Apin indicates that the series was not an "astronomical" compendium, but a divinatory collection of ideal schemes. It is no surprise, then, that from IIii16 to its end[309] (IIiv12) Mul.Apin was concerned only with celestial omens. Its purpose was not distinct from that of EAE.

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[305] Since the average length of a lunation is $29^{1}/_{2}$ days, 12 months is about 354 days. One additional month every 36 means that $12^{1}/_{3}$ months last 364 days, close to the real length of a year, especially considering that in any given year the number of 29-day and 30-day months may not be the same. The figure of 364 UŠ in the *ziqpu* list AO6478 (App.1 §33) perhaps derives from this reasoning – see Horowitz (1994) 94, but also Koch (1996).

[306] In i.NAM.giš.ḫur.an.ki.a II26 it states that 1,40 ud.da.zal-*e u$_4$-mu*, which is translated by Livingstone *MMEW* p25 as "$1^{2}/3$ of a longest day is a day" based on the apparent meaning of the Sumerian. This would have implied a ratio of the longest to the shortest day of 3: 2. However, line Iiii14 in Mul.Apin makes it clear that the text should now be read as "1,40, the correction for a day" which derives from the 10 "ideal intercalary days per year – the ideal *epact*" divided by 360. The earliest attestation of the 3: 2 ratio is in the late NA period in BM 36731 – see App.1 §38.

[307] Most famously by Neugebauer (1947a). This desire to find amongst the Mesopotamians the same interests as we might have is typical of much that is said about the so-called "astronomical" texts written before the late NA period.

[308] For details see Brown, Fermor & Walker (1999).

[309] Assuming it to be only two tablets long.