Article

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On the origin of the 12 zodiac constellation system in ancient Mesopotamia

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Abstract

This article pursues two main goals: (1) to reconstruct the history of the 12 zodiac constellation system in the astronomy of ancient Mesopotamia; (2) to reveal traces of this system directly in cuneiform texts. Among the most important circumstances led to appearance of this system: (1) development of ideas about the band of zodiac constellations, including—according to MUL.APIN—the total of 18 (or 17) constellations; (2) usage of the schematic year, containing 12 months, 30 days each, and (3) development of ideas about mathematical or uniform zodiac, subdivided into 12 equal parts, 30° each. A sequence of the so-called *Normal stars* singled out in the zodiacal band is an additional important source shedding light on the history of the Mesopotamian zodiac. The designations of *Normal stars* adopted *in Astronomical diaries* and other texts indicate that the system of 18 constellations was used in Mesopotamia until the end of cuneiform civilization. This means that in the second half of the first millennium BC the system of 18 constellations, adopted in MUL.APIN, and the system of 12 zodiacal constellations, borrowed from Babylonians by Greek astronomers, were used in parallel. It is also shown in the article that the system of 12 zodiac constellations was used in magical and astrological text BRM 4.20, dated back approximately to the last third of the fourth century BC.

Keywords

Equal-sign zodiac, history of zodiac, normal stars, zodiac constellations

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Introduction

Some concepts in the history of astronomy have seriously affected the development of science and culture in many regions. The concept of zodiac is one of them. The zodiac as a band of constellations, within which visible motions of the Moon and planets occur, played an important role in the astronomy of ancient Mesopotamia, ancient Greece, and countries of Islam. The ideas associated with the zodiac had not only astronomical but also astrological and religious significance. The history of Mesopotamian zodiac is of particular importance, since it had a direct impact on the formation of ideas about the zodiac in ancient Greece and in Islamic countries, and through them in Europe.

The history of the Mesopotamian zodiac is a long and carefully studied issue.[1] It is subdivided into two key problems closely related to each other: (1) the discovery of the band of zodiacal constellations through which the Sun, Moon, and five planets move, and (2) the division of the zodiacal band into 12 equal parts to form the so called uniform zodiac used in mathematical astronomy. Sources related to the history of zodiac are cuneiform texts of various types (not only astronomical), dated mainly from the first millennium BC. This article will investigate just one aspect of the zodiac history—the question of when and how a system of 12 zodiac constellations was developed in Mesopotamia. We also set the task of identifying traces of this system directly in cuneiform sources. Surprisingly, in the existing historical and scientific literature this question has not been studied yet. But when examined in detail on the basis of authentic sources, the answer to this question might appear to be not so simple and not so obvious.

The band of zodiacal constellations

The discovery of the band of zodiacal constellations is one of the most outstanding achievements of Mesopotamian astronomy.[2] It was preceded by two events: first, creation of the constellation system that covered almost the entire sky, and second, distinguishing of planets as a special category of stars. In the Old Babylonian period (19th–16th centuries BC) the system of Mesopotamian constellations already existed, apparently in almost complete form.[3] The planets as a special category of stars became also known no later than in the Old Babylonian period; it is the time to which we attribute the earliest known usage of the term MUL.UDU.IDIM,[4] lit. “wild sheep”—a standard designation of planets in astronomical and astrological texts of later time.[5]

When was the band of zodiacal constellations discovered? There are many texts dating back to the second millennium BC, mentioning constellation names. None of them, however, contains any data indicating that this concept was already known in this period. Cuneiform sources do not single out the zodiac constellations from other constellations. In lexical texts they are found irregularly, alternating in random way with non-zodiac constellations. There is no reason to believe that zodiacal constellations played any special role in astronomy of that time. The concept of the band of zodiacal constellations was not yet known at that period.[6]

The situation changed significantly in the Neo-Assyrian period (10th–7th centuries BC). In Mesopotamia of that time the astronomical observations began to be carried out, that inevitably had to lead to discovery of zodiac.

A definition of the zodiac as a constellation band is first encountered in an explicit form in the astronomical treatise MUL.APIN (I iv 31–39). Its earliest copies date back to the beginning of seventh century BC, but some fragments apparently date back to the second half of the second millennium BC.[7]

It says:

> "The gods who stand in the path of the Moon,[8] through whose regions the Moon in the course of a month passes and whom he touches: The Stars, the Bull of Heaven, the True Shepherd of Anu, the Old Man, the Crook, the Great Twins, the Crab, the Lion, the Furrow, the Scales, the Scorpion, Pabilsag, the Goat-Fish, the Great One, the Tails, the Swallow, Anunitu, and the Hired Man."[9]

This text contains 18 constellations, through which the Moon passes during its monthly motion.[10] Almost all of them are well known from earlier texts. This list obviously has an astronomical basis; the constellations are listed in it according to their increasing longitude.[11] It contains results of observations of the Moon motion relative to the fixed stars. This is a fundamental difference between the Mesopotamian zodiac and the Greek, which was originally associated with the Sun.

A list of relevant constellations is adduced in the Table 1 (column 1). It contains: (1) transliterations or transcriptions of the constellation names from MUL.APIN, (2) translations of the names, and (3) identifications with stars established in modern research (in parentheses); in some cases these are only approximate identifications.[12]

If you interpret this list as the list of *all* constellations singled out in the zodiacal band, you have to conclude that it is incomplete. It does not contain the names of four constellations (known from other sources) that were fully or partially located in the zodiacal band. Those are the following constellations:

1. $^{mul\ giš}$GIGIR "The Chariot" (northern part of Taurus, including β and ζ Tauri);[13]
2. ^{mul}MAŠ.TAB.BA.TUR.TUR "The Little Twins" (ζ and λ Gemini?);
3. ^{mul}MAŠ.TAB.BA *ša*$_2$ IGI-*it* ^{mul}SIPA.ZI.AN.NA "The Twins who are opposite the True Shepherd of Anu" (γ, ε Gemini);
4. ^{mul}AŠ.GAN$_2$ "The Field" (Pegasus square + a part of the constellation Pisces).[14]

These constellations are found in other sections of MUL.APIN, but formally they are not associated there with the band of zodiacal constellations.[15]

Thus, it can be stated that Mesopotamian astronomers have singled out at least 22 constellations in the zodiacal band in the first millennium BC.

After the definition of "the path of the Moon" in MUL.APIN (II i 1–8) the definitions of the "paths" of the Sun and five planets follow separately. They argue that the "paths" of all planets and the Sun relative to the stars are the same; they correspond to "the path of the Moon."[16] A distinctive feature is: in this definition Sun is interpreted as one of the planets; its special position among other luminaries is not singled out.

In the Neo-Assyrian period Mesopotamian astronomers (astrologers) carefully observed positions of the Moon and planets relative to fixed stars and constellations. The

Table 1. The band of zodiacal constellations in different sources.

1	2	3	4
MUL.APIN	*Letters* and *Reports*	MNB 1849	*Normal Stars*
1. MUL.MUL "The Stars" (Pleiades) 2. ^{mul}GU$_4$.AN.NA "The Bull of Heaven" (Hyades + Aldebaran) 3. ^{mul}SIPA.ZI.AN.NA "The True Shepherd of Anu" (Orion) 4. ^{mul}ŠU.GI "The Old Man" (Perseus + northern part of Taurus) 5. ^{mul}GAM$_3$ "The Crook" (Auriga) 6. ^{mul}MAŠ.TAB.BA.GAL.GAL "The Great Twins" (Gemini) 7. ^{mul}AL.LUL "The Crab" (Cancer) 8. ^{mul}UR.GU.LA "The Lion" (Leo) 9. ^{mul}AB.SIN$_2$ "The Furrow" (Virgo) 10. ^{mul}*Zi-ba-ni-tu*$_4$ "The Scales" (Libra) 11. ^{mul}GIR$_2$.TAB "The Scorpion" (Scorpio) 12. ^{mul}*Pa-bil-sag* "Pabilsag" (Sagittarius) 13. ^{mul}SUḪUR.MAŠ$_2$ "The Goat-Fish" (Capricorn) 14. ^{mul}GU.LA "The Great One" (Aquarius) 15. <^{mul}>KUN.MEŠ "The Tails" (southern part of Pisces) 16. ^{mul}SIM.MAḪ "The Swallow" (western part of Pisces) 17. ^{mul}*A-nu-ni-tu*$_4$ "Anunitu" (north-eastern part of Pisces) 18. ^{mul}LU$_2$.ḪUN.GA$_2$ "The Hired Man" (Aries)	1. MUL.MUL (or ^{d}7.BI) 2. ^{mul}GU$_4$.AN.NA (or ^{mul}*Is lê*) 3. ^{mul}SIPA.ZI.AN.NA 4. ^{mul}ŠU.GI 5. ^{mul}GIŠ.GIGIR (or ^{mul}EN.ME.ŠAR$_2$.RA) 6. ^{mul}GAM$_3$ (= ^{mul}ZUBI) 7. ^{mul}MAŠ.TAB.BA.GAL.GAL (or ^{mul}MAŠ.TAB.BA or ^{d}*Māšu* or $^{mul}u_2$-*ṣur-ti*) 8. ^{mul}AL.LUL 9. ^{mul}UR.GU.LA (or ^{mul}UR.MAḪ) 10. ^{mul}AB.SIN$_2$ 11. ^{mul}*Zi-ba-ni-tu*$_4$ (or ^{mul}ZI.BA.AN.NA) 12. ^{mul}GIR$_2$.TAB 13. ^{mul}*Pa-bil-sag* 14. ^{mul}SUḪUR.MAŠ$_2$.KU$_6$ 15. [^{mul}GU.LA] 16. ^{mul}KUN.MEŠ 17. ^{mul}SIM.MAḪ 18. ^{mul}*A-nu-ni-tu*$_4$ 19. ^{mul}AŠ.GAN$_2$ 20. ^{mul}LU$_2$.ḪUN.GA$_2$	1. MUL.MUL 2. ^{mul}ŠU.GI 3. ^{mul}GU$_4$.AN.NA 4. ^{mul}SIPA.ZI.AN.NA 5. ^{mul}*Zi-ba-ni-tum* 6. ^{mul}MAŠ.TAB.BA.GAL.GAL.LA 7. ^{mul}GIR$_2$.TAB 8. ^{mul}PA.BIL.SAG 9. ^{mul}GU.LA 10. ^{mul}SUḪUR.MAŠ$_2$.KU$_6$ 11. ^{mul}UR.GU.LA 12. ^{mul}AB.SIN$_2$ 13. ^{mul}AL.LUL 14. ^{mul}*A-nu-ni-tum* 15. ^{mul}ŠIM.MAḪ 16. ^{mul}LU$_2$.ḪUN.GA$_2$	1. ḪUN (or LU) "The Hired Man" 2. MUL$_2$.MUL$_2$ (or MUL$_2$) "The Stars" 3. GU$_4$.AN.NA, GU$_4$.AN (or *Is le*$_{10}$) "The Bull of Heaven" or "The Jaw of the Bull" 4. GIGIR "The Chariot" 5. MAŠ.MAŠ "The Twins" 6. MAŠ.MAŠ *ša*$_2$ SIPA "The Twins near the Shepherd" 7. ALLA "The Crab" 8. A (or UR.A) "The Lion" 9. ABSIN "The Furrow" 10. RIN$_2$ (= ERIN$_2$) "The Scales" 11. GIR$_2$.TAB "The Scorpion" 12. PA (or PA.BIL) "Pabilsag" 13. SUḪUR.MAŠ$_2$ (or MAŠ$_2$) "The Goat-Fish" 14. GU "The Great One" 15. SIM.MAḪ "The Swallow" 16. KUN.MEŠ (or KUN.ME, *zib*^{me}) "The Tails" 17. *nu-nu*, lit. "Fish," apparently, *Anunītu*

Letters and *Reports* of the court astrologers to the Assyrian kings, dating mainly from the seventh century BC, testify this.[17] We list some observations of this time, in which stars and constellations from the zodiacal band were involved: (1) occultations of fixed stars by the Moon, (2) lunar halos positions with respect to constellations, (3) first visibility of the moon crescent relative to constellations, (4) lunar positions during eclipse with respect to constellations, (5) constellations within which heliacal risings or settings of planets were observed, (6) current planetary positions, including stations and retrogradations, with respect to constellations, etc.[18] There is no doubt that during that period they already knew that the Moon and planets, when they move relative to fixed stars, never go beyond the narrow band of constellations. This idea, however, is not explicitly mentioned in observational texts.

The exact time when MUL.APIN treatise was created is unknown. The last modern dating: the end of the second or, more likely, the beginning of the first millennium BC (in Babylon).[19] Accordingly it is not known what time the fragment of MUL.APIN we are interested in should be dated. However, it is obvious that it should have been preceded by observations from among those listed by us, most likely those related to the positions of the moon, lunar halos and lunar eclipses relative to constellations.

The *Letters* and *Reports* allow us to reconstruct the list of constellations from the zodiacal band known to Mesopotamian astronomers in the seventh century BC. A list of these constellations is presented in the Table 1 (column 2). A comparison with the list from MUL.APIN reveals an almost complete correspondence. Scholars who compiled the list of constellations "in the path of the moon" from MUL.APIN and authors of the *Letters* and *Reports* had the same ideas about the structure of zodiacal band. The only difference concerns the constellation ^{mul}GU.LA "The Great One," which is not mentioned in *Letters* and *Reports*. We consider this to be an accident of no fundamental importance.

Of particular interest to us is the fate of zodiac constellations from MUL.APIN in Mesopotamian astronomy and beyond.

Sixteen constellations from the list of MUL.APIN are mentioned in the Late Babylonian astrological text MNB 1849, rev. 37–54.[20] Omens in it follow to a standard scheme: DIŠ *ina* KI MUL . . . (^{d}*sin*) *a-dir* . . . "If (the Moon) is eclipsed in the region of constellation. . .," each one contains the names of one or two constellations from the zodiacal band. The heading of the text has the following shape*:* KI.MEŠ MUL.MEŠ *ša ina lib*$_3$*-bi* ^{d}*sin* AN-KU$_{10}$ GAR-*nu* . . ., which means "The regions of stars within which the Moon makes an eclipse . . .."[21] This heading may be considered as once more definition of the band of zodiacal constellations "in the path of the Moon." A list of constellations mentioned in this text is presented in the Table 1 (column 3), constellations in it are listed according to the order adopted in MNB 1849. In comparison with the list of MUL.APIN only ^{mul}GAM$_3$ "The Crook" and ^{mul}KUN.MEŠ "The Tails" are missing in this text. We can draw a conclusion, in the period when this text was created, the list of constellations "in the path of the Moon" from MUL.APIN was well known to Mesopotamian astrologers.

Normal stars and the zodiac constellations from MUL.APIN

Besides constellations, in the first millennium BC Mesopotamian astronomers also singled out about 40 unevenly distributed stars in the zodiac band.[22] Modern scholars call

them *Normal stars*. In cuneiform sources they were designated as MUL_2.ŠID.MEŠ, lit. "The stars (for) counting." The so-called *Astronomical Diaries* and other texts regularly recorded the positions of the Moon and planets relative to them.[23] Each such star had its own special name, which combined the name of constellation from MUL.APIN, often in an abbreviated form,[24] and the name of constellation figure element with which this star was associated.

Examples of *Normal Star* names:

MUL_2 IGI $ša_2$ SAG ḪUN "The front star[25] of the head of the Hired Man" (β Arietis);

ŠUR GIGIR $ša_2$ SI "The Northern rein of the Chariot" (β Tauri);

MAŠ.MAŠ $ša_2$ SIPA "The Twins near the Shepherd" (γ Geminorum);

MAŠ.MAŠ IGI "The front Twin star" (α Geminorum);

MAŠ.MAŠ ar_2 "The rear Twin star" (β Geminorum);

MUL_2 IGI $ša_2$ ALLA $ša_2$ SI "The front star of the Crab to the North" (η Cancri);

LUGAL "The King" (α Leonis);

MUL_2 TUR $ša_2$ 4 $KUŠ_3$ ar_2 LUGAL "The small star which is 4 cubits behind the King" (ρ Leonis);

GIR_3 ar_2 $ša_2$ A[26] "The rear foot of the Lion" (β Virginis);

SA_4 $ša_2$ ABSIN "The bright (star) of the Furrow" (α Virginis);

RIN_2 $ša_2$ ULU_3 "The southern part of the Scales" (α Librae);

MUL_2 *e* $ša_2$ SAG GIR_2.TAB "The upper star of the Head of Scorpion" (β Scorpii);

MUL_2 KUR $ša_2$ KIR_4 *šil* PA "The bright star on the tip of Pabilsag's arrow" (θ Ophiuchi);

MUL_2 ar_2 $ša_2$ SUḪUR.$MAŠ_2$ "The rear star of the Goat-Fish" (δ Capricorni);

DUR SIM.MAḪ "Swallow Ribbon" (probably ε Piscium or a group of stars including this star).

Observations of the Moon and planets passages regarding *Normal stars* and other data from *Astronomical Diaries* allow reconstructing the list of constellations that were singled out in the zodiacal band in the corresponding period. This list is adduced in the Table 1 (column 4).

The list includes the total of 17 constellation names, of which almost all are presented in the list of "the gods in the path of the Moon" from MUL.APIN. All that is missing is the constellation ^{mul}ŠU.GI "The Old Man" (^{mul}GIGIR was used instead) and $^{mul}GAM_3$ "The Crook." Without knowing these constellations—their figures and positions relative to the stars—it was impossible to determine the positions of *Normal stars* in the sky. Since *Normal stars* were used in astronomical texts up to the first century AD, it can be concluded that a system of the zodiac constellations from MUL.APIN was in use until the end of cuneiform civilization. It is known also that the MUL.APIN treatise continued to be copied and quoted in Mesopotamia at least until the last centuries BC.[27] Evidence of this system can also be found in Greek astrology. The constellation Swallow-Fish is mentioned in one Greek horoscope of the first century AD.[28]

The system of 12 zodiacal constellations

It was the system that Greeks encountered when they borrowed the zodiac in Ancient Mesopotamia (the end of the fifth to the beginning of the fourth century BC).[29] How did the system of 18 constellations from MUL.APIN turn into a system of 12 constellations? Why did Mesopotamian astronomers need to modernize the constellation system from MUL.APIN? The answer is probably contained in the text of the fifth century BC (WA 77824), in which the 15 zodiac constellations are divided into 12 parts, corresponding to the 12 months of the Mesopotamian calendar.[30] Perhaps it refers to the annual movement of the Sun relative to constellations.

Text of tablet consists of two columns; the first column shows the names of the Babylonian calendar months,[31] the second—the names of corresponding zodiacal constellations.

Text WA 77824

I. $MUL_2.LU_2.ḪUN.GA_2$

II. $MUL_2.MUL_2$ *u* $MUL_2.GU_4.AN.NA$

III. $MUL_2.SIPA.ZI.AN.NA$ *u* $MUL_2.MAŠ.TAB.BA.GAL.GAL$

IV. $MUL_2.AL.LUL$

V. $MUL_2.UR.GU.LA$

VI. $MUL_2.AB.SIN_2$

VII. MUL_2.*Zi-ba-nit*

VIII. $MUL_2.GIR_2.TAB$

IX. $MUL_2.PA.BIL.SAG$

X. $MUL_2.SUḪUR.MAŠ_2$

XI. $MUL_2.GU.LA$

XII. $MUL_2.AŠ.GAN_2$ *u* $MUL_2.KUN.MEŠ$

The decisive role in establishing the system of 12 constellations, apparently, was played by the so-called schematic calendar, in which the year contained only 12 months, 30 days each (it did not involve intercalations).[32] This text is an intermediate step because it contains not 18, but 15 constellations. “The Old Man,” “The Crook,” “The Swallow,” and “Anunitu” were discarded, but “The Field,” which was not in the original list from MUL.APIN, was added. The 12 calendar months suggested 12 constellations in the zodiacal band. Thus, in this list 15 constellations were subdivided into 12 parts in such a way that for each of the months II (Ajjaru), III (Simanu), and XII (Addaru) 2 constellations were attributed. This is the earliest text in the history of astronomy known to us in which number 12 relates to the band of zodiacal constellations.

In order to get a system of 12 constellations, you need to make a choice and discard some of the double names. And that was actually done. Mesopotamian astronomers

discarded the constellations which only by their small part entered the zodiacal band. In this case, it is "The True Shepherd of Anu" (Orion) and "The Field" (Pegasus square + a part of Pisces). As for "The Stars" (= Pleiades) and "The Bull of Heaven" (= Hyades + Aldebaran), the question is more complicated. If in Greece the second zodiac constellation is, as a rule, Taurus, then in Mesopotamia, on the contrary, most texts use one of the spellings of MUL.MUL.

The most important additional impulse for the transition to the system of 12 zodiac constellations was establishing mathematical or uniform zodiac, a circle or band on the celestial sphere, subdivided into 12 equal parts of 30° each.[33] Their names were related to the names of the zodiac constellations but were given in abbreviations.

Modern scholars attribute the introduction of mathematical zodiac to the end of the fifth—the beginning of the fourth century BC,[34] and this in general is consistent with Greek sources. After mathematical zodiac was established in Mesopotamian astronomy, an inconsistent situation developed there: following MUL.APIN, 18 constellations were singled out in the band of zodiacal constellations, while the mathematical zodiac contained only 12 parts. A scale of 12 signs of the zodiac assumed 12 constellations in the zodiac band.

I believe that such a chronological order did take place: first, the mathematical zodiac, associated with the schematic year, appeared and only then the 12 zodiac constellation system was introduced. The opposite point of view is also expressed in the literature: first a system of 12 zodiac constellations arose and only then a mathematical zodiac was introduced, the latter was subdivided into 12 equal parts,[35] which, in our opinion, does not correspond reality.

This can be seen from the following considerations.

It is known that the names of 12 zodiacal signs used in mathematical astronomy and in other texts (where the uniform zodiac was used) were associated with the names of zodiacal constellations. The standard sequence of designations used in the *Astronomical Diaries* and in the texts related to mathematical astronomy in the Seleucid period were as follows:

ḪUN, LU "The Hired Man" (Aries),

MUL_2.MUL_2, MUL_2 "The Stars" (Taurus),

MAŠ.MAŠ, MAŠ "The Twins" (Gemini),

ALLA "The Crab" (Cancer),

A "The Lion" (Leo),

ABSIN (Virgo),

RIN_2 "The Scales (Libra),

GIR_2.TAB, GIR_2 "The Scorpion" (Scorpio),

PA "Pabilsag" (Sagittarius),

SUḪUR.$MAŠ_2$, $MAŠ_2$ "The Goat-fish" (Capricorn),

GU "The Great One" (Aquarius),

zib^{me}, *zib* "The Tails" (Pisces).[36]

If the system of 12 zodiacal constellations arose before the uniform zodiac (as is sometimes assumed), it is natural to suppose that the constellation names adopted in it served as a basis for the names of 12 zodiac signs. However, this is not the case in reality. The naming system for the zodiac signs has not been stable. There were quite a few variants of the zodiac sign naming in the texts, where the uniform zodiac and the so-called micro-zodiac were used. These names correspond to the band of zodiacal constellations, as it is presented in the text BM 77824, as a system of 15, not 12 constellations. For example, along with the standard accepted names the second sign of the zodiac (Taurus) could be designated as GU_4, the third sign of the zodiac (Gemini) as SIPA, and the 12th sign of the zodiac (Pisces) as $AŠ.GAN_2$.[37] If we were dealing with a system of 12 zodiacal constellations as a prototype, such a variety of designations would be impossible. Thus, there is no reason to suppose the existence of the system of 12 zodiacal constellations in the period preceding the introducing of the uniform zodiac.

The system of 12 zodiacal constellations in Mesopotamian texts

The system of 12 constellations undoubtedly existed in Mesopotamia in the second half of the first millennium BC. But there are not so many reliable evidences, especially evidences that would allow establishing the time of introduction of the 12 constellation system. Since the designations of the zodiac signs and the constellations, as a rule, coincided, it is difficult to say what was meant in texts—the constellations or the signs of the zodiac.

Let us consider two examples.

The Seleucid text LBAT 1591 obv. 1–4 gives the names of the five planets, followed by 12 signs of the zodiac or the zodiacal constellations[38]; a standard interpretation—it is the designations of zodiac signs[39]; however, in our opinion, it is not known exactly how to interpret these names.

The magical and astrological text BRM 4.20 can also serve as an example.[40] It provides a list of rituals along with related dates of their performance. It is assumed that the ritual will be successful if during its holding an unknown planet (according to E. Reiner, the Moon) is in a certain position on the zodiac. For example, "(Rite) 'love of a man for a woman' (is to be performed when any planet/the Moon) is in the region of Scales (KI ^{mul}*zi-ba-nu*)" (BRM 20.4:5), or "(Rite) 'visiting the palace' (is to be performed when any planet/the Moon) is in the region of Crab (KI ^{mul}AL.LU_5)" (BRM 4.20:12), etc. for all zodiacal constellations (or zodiac signs?), a number of which is 12. Whether in this case the text is talking about constellations or the zodiac signs is initially unclear.[41] However, one peculiarity allows us to solve the problem. The general list contains the indications related to the star Aldebaran: "(Rite) 'for the putting down of silver' (is to be performed, when any planet/the Moon) is in the region of the bright star of Bull of Heaven (KI SA_4 $ša_2$ $^{mul}GU_4$.AN.NA)," as well as related to the star Regulus: "(Rite) 'to return a runaway' (is to be performed when any planet/the Moon) is in the area of King or Scales (KI

^{mul}LUGAL *ša*$_2$*-niš* KI ^{mul}*zi-ba-nu*)" (BRM 4.20:19–20). And in another place: "(Rite) 'the king in his palace will mention his name with warmth' (is to be performed when any planet/the Moon) is in the area of 5 cubits in front of [Regulus] (KI 5 UŠ *ina* IGI ^{mul}[LUGAL])" (BRM 4.20: 14). I believe that the presence in this text of the names of stars that can be directly observed in the sky, indicates that other constellation names, found in the same text, also relate to observable objects.

This means that we are dealing here with constellations: the text uses the system of 12 zodiac constellations. Their designations are as follows: ^{mul}LU$_2$.ḪUN.GA$_2$ (Aries), MUL.MUL (Taurus), ^{mul}MAŠ.TAB.BA.GAL.GAL or MAŠ.MAŠ (Gemini), ^{mul}AL.LU$_5$ (Cancer), ^{mul}UR.A (Leo), ^{mul}AB.SIN$_2$ or ^{mul}ABSIN (Virgo), ^{mul}*zibānu* or ^{mul}GIŠ.RIN$_2$ (Libra), ^{mul}GIR$_2$.TAB (Scorpio), ^{mul}PA.BIL.SAG (Sagittarius), ^{mul}SUḪUR.MAŠ$_2$ (Capricorn), ^{mul}GU.LA (Aquarius), ^{mul}KUN.MEŠ (Pisces). This text is attributed to the end of the Achaemenid period or the early Seleucid period, that is, it is not older than the last third of the fourth century BC. In many other cases, however, a clear answer regarding text dating and meaning of designations used in it, is not possible.

Conclusion

In conclusion, let us sum up. There is a reason to believe that the concept of the band of zodiacal constellations was not known in Mesopotamia of the second millennium BC. The situation changed in the Neo-Assyrian period. The definition of the band of 18 (or 17) constellations is found in the MUL.APIN treatise. Regular observations of the Moon and planets relative to constellations and fixed stars, carried out during this period, led to the discovery of the band of zodiacal constellations. Observation data on the passages of the Moon and planets relative to *Normal stars* in the *Astronomical Diaries* and other texts indicate that the system of 18 constellations was used in Mesopotamia until the end of cuneiform civilization. It was also partly known to Greek astrology. At the same time a system of 12 zodiac constellations was forming. The main role in it was played by schematic calendar and associated uniform zodiac, which was divided into 12 equal parts of 30° each. The 12-part division of the schematic calendar and the uniform zodiac suggested singling out of 12 constellations in the zodiacal band. For the first time, the number 12 was related to the band of zodiacal constellation in the text WA 77824, which dates back to the fifth century BC. In the fourth century BC the system of 12 zodiacal constellations was apparently already quite widespread in Mesopotamia.

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Note on contributor

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Notes

1. For the history of Mesopotamian zodiac first of all see: B.L. van der Waerden, "History of the Zodiac," *Archiv für Orienforschung*, 16 (1952–53), 216–30; B.L. van der Waerden (with contributions by P. Huber), *Science Awakening II. The Birth of Astronomy* (Leyden: Noordhoff International Publishing; New York: Oxford University Press, 1974); L. Brack-Bernsen and H. Hunger, "The Babylonian Zodiac: Speculations on Its Invention and Significance," *Centaurus*, 41 (1999), 280–92; L. Brack-Bernsen, "The Path of the Moon, the Rising Points of the Sun, and the Oblique Great Circle on the Celestial Sphere," *Centaurus*, 45 (2003), 16–31; F. Rochberg, *The Heavenly Writing* (Cambridge: Cambridge University Press, 2004), p. 126–133; J. Steele, "The Development of the Babylonian Zodiac: Some Preliminary Observations," *Mediterranean Archaeology and Archaeometry*, 18, (2018), 97–105, as well as G.E. Kurtik, "O proiskhozhdenii nazvaniy grecheskih zodiakalnyh sozvezdiy [On the origin of the Greek zodiacal constellations names]," *Voprosy istorii estestvoznaniya i tekhniki [Studies in the history of science and technology]*, 1 (2002), 76–106 (in Russian). See also basic research: H.G. Gundel and R. Böker, "Zodiakos," in: *Pauli-Wissowa, Realencyclopedia der classischen Altertumswissenschaft*, Bd. X A (1972), Kol. 462–709; H.G. Gundel, *Zodiakos: Tierkreisbilder im Altertum* (Main am Rhein: Verlag P. von Zabern, 1992); specified works contain an extensive bibliography on zodiac history.
2. For detailed study of this issue see G.E. Kurtik, "Vvedeniye zodiaka kak polosy sozvezdiy v mesopotamskoy astronomii [The introduction of the zodiac as the band of constellations in Mesopotamian astronomy]," *Voprosy istorii estestvoznaniya i tekhniki [Studies in the history of science and technology]*, 1 (2012), 23–32 (in Russian).
3. For the constellation names found in the Old Babylonian cuneiform sources of various types, see G.E. Kurtik, "Nazvaniya sozvezdiy v mesopotamskih istochnikah pervoy poloviny II tys. do n.e. i problema proiskhozhdeniya sozvezdiy [The constellation names in Mesopotamian sources of the first half of the second millennium BC and the problem of the origin of constellations]," *Vestnik drevney istorii [Journal of Ancient History]*, 77 (2017), 821–39 (in Russian).
4. MUL.UDU.TIL, according to modern interpretations, see Y. Bloch and W. Horowitz, "URA=ḪUBULLU XXII: The Standard Recension," *Journal of Cuneiform Studies*, 67 (2015), 71–125, especially p. 106; E. Reiner, *Astral Magic in Babylonia* (Philadelphia: American Philosophical Society, 1995), p. 7, (Note 22).
5. This term is found for the first time in Old Babylonian lexical texts, see *Materials for the Sumerian Lexicon. Vol. XI. The Series HAR-ra = hubullu. Tablets XX–XXIV*. Ed. by E. Reiner with the coll. of M. Civil (Roma: Pontificium Institutum Biblicum, 1974), p. 108:400, 143 col. x 22; W. Horowitz, "Some Thoughts on Sumerian Star-Names and Sumerian Astronomy," in Y. Sefati, P. Artzi, C. Cohen, B.L. Eichler and V.A. Hurowitz (eds), *An Experienced Scribe Who Neglects Northing. Ancient Near Eastern Studies in Honor of Jacob Klein* (Bethesda: University Press of Maryland, 2005).
6. Kurtik, *op. cit* (Note 2), p. 24–6.
7. For modern editions of MUL.APIN treatise with astronomical and philological commentaries see H. Hunger and D. Pingree, *MUL.APIN: An Astronomical Compendium in Cuneiform* (Horn: Verlag Ferdinand Berger & Söhne Gesselschaft, 1989); R. Watson and W. Horowitz,

Writing Science before the Greeks. A Naturalistic Analysis of the Babylonian Astronomical Treatise Mul.Apin (Leiden: Brill Academic Publication, 2011); H. Hunger and J. Steele, *The Babylonian Astronomical Compendium MUL.APIN* (London & New York: Routledge, 2018).

8. *ina* KASKAL *Sîn*, lit. "in the path of (the moon deity) Sin."
9. Hunger and Pingree, *op. cit.* (Note 7), pp. 67–9.
10. Modern scholars sometimes determine the number of constellations in this list as 17. This is due to the way of reading and interpretation of cuneiform text, see Hunger and Pingree, *op. cit.* (Note 7), p. 144; Hunger and Steele, *op. cit.* (Note 7), pp. 195–6; Brack-Bernsen, *op. cit.* (Note 1), p. 17.
11. This rule was not strictly followed. The correct sequence for "the Tails, the Swallow, Anunitu," apparently, should be "the Swallow, the Tails, Anunitu," see Hunger and Steele, *op. cit.* (Note 7), p. 196.
12. For each of these constellations see relevant articles in G.E. Kurtik, *Zvezdnoye nebo drevney Mesopotamii* [The Star Heaven of Ancient Mesopotamia] (Moscow: Aletheia, 2007) (in Russian). The identifications adopted in various modern research are also presented in this volume.
13. This constellation is not mentioned in the MUL.APIN list, probably, because it was considered as a part of ^{mul}ŠU.GI, see Kurtik, *op. cit.* (Note 12), e11, g15, sh16.
14. For the identification of ^{mul}AŠ.GAN$_2$ see E. Reiner and D. Pingree, *Babylonian Planetary Omens. Part Three* (Groningen: STYX Publications, 1998), p. 7; Kurtik, *op. cit.* (Note 12), a48. A number of constellations from the zodiacal band, not included in the star list "in the path of the moon" from MUL.APIN, is estimated differently in modern research. J. Steele in the article *op. cit.* (Note 1), p. 98 adduces only two such constellations ($^{mul\ giš}$GIGIR and ^{mul}AŠ.GAN$_2$), but in reality their number was greater.
15. See relevant articles g15, m18, m19, a48 in Kurtik, *loc. cit.* (Note 12).
16. Hunger and Pingree, *op. cit.* (Note 7), pp. 70–1; Hunger and Steele, *op. cit.* (Note 7), pp. 71–2.
17. S. Parpola, *Letters from Assyrian and Babylonian Scholars* (Helsinki: Helsinki University Press, 1993); H. Hunger, *Astrological Reports to Assyrian Kings* (Helsinki: Helsinki University Press, 1992).
18. Parpola, *loc. cit.* (Note 17); Hunger, *loc. cit.* (Note 17); Kurtik, *op. cit.* (Note 2), pp. 26–9.
19. For a detailed discussion of this problem with the results obtained by other scholars, see Hunger and Steele, *op. cit.* (Note 7), pp. 16–9. See also Hunger and Pingree, *op. cit.* (Note 7), pp. 10–2; Watson and Horowitz, *op. cit.* (Note 7), pp. 3–6.
20. An appropriate fragment is published in E. Weidner, "Astrologische Geographie im Alten Orient," *Archiv für Orientforschung*, 20 (1963), 117–21; its duplicate from *EAE* see in F. Rochberg-Halton, *Aspects of Babylonian Celestial Divination: The Lunar Eclipse Tablets of Enūma Anu Enlil* (Horn: Verlag Ferdinand Berger & Söhne Gesellschaft, 1988). *EAE* 20 text a ii 1′–6′. A new edition of the text see: J. Steele, "Mesopotamian Astrological Geography," *The Star of Bethlehem and the Magi.* Edited by P. Bartel and G. van Kooten (Leiden–Boston: Brill, 2015), pp. 201–16.
21. Rochberg-Halton, *op. cit.* (Note 20), pp. 10–1; Steele, *op. cit.* (Note 20), pp. 208–10.
22. The basic list included 28 stars, but there were also other stars from the zodiacal band that Mesopotamian astronomers used in observations, see A. Sachs and H. Hunger, *op. cit.* (Note 23), pp. 17–19; N.A. Roughton, J.M. Steele and C.B.F. Walker, "A Late Babylonian Normal and *Ziqpu* Star Texts," *Archive for History of Exact Sciences*, 58 (2004), 537–572, esp. pp. 550–4, 565–70, Ap. B; A.A. Jones, "Study of Babylonian Observations of Planets Near Normal Stars," *Archive for History of Exact Sciences*, 58 (2004), 475–536, esp. pp. 481–4; J.P. Britton, "Studies in Babylonian lunar theory: part III. The introduction of the uniform zodiac," *Archive for History of Exact Sciences*, 64 (2010), 617–63, especially p. 621; Kurtik,

op. cit. (Note 12), m39.

23. The earliest known text of *Diaries* dates back to −651, the latest *Diary* is attributed to the middle of the first century BC. Observations of this type were carried out in Mesopotamia, apparently, from the middle of the eighth century BC. For publications of the texts of *Diaries* see A. Sachs, H. Hunger, *Astronomical Diaries and Related Texts from Babylonia*. Vol. 1: Diaries from 652 B.C. to 262 B.C.; Vol. 2: Diaries from 261 B.C. to 165 B.C.; Vol. 3: Diaries from 164 B.C. to 75 B.C. (Wien: Verlag der Osterreichischen Akademie der Wissenschaften, 1988, 1989, 1991).
24. Some abbreviations of constellation names used in the *Normal stars*: ḪUN, LU from $^{mul}LU_2$. ḪUN.GA_2, SIPA from ^{mul}SIPA.ZI.AN.NA, A from UR.A, PA from ^{mul}*Pa-bil-sag*, $MAŠ_2$ from $^{mul}SUḪUR.MAŠ_2$, GU from ^{mul}GU.LA *et al.* Mesopotamian scribes preserved (as a rule but not always) those cuneiform signs that were easier to write.
25. "The front star" is a star that first appears during the daily motion of celestial sphere.
26. The texts of the first millennium BC also not infrequently used ^{mul}UR.A "The Lion" as designation of Leo, from which an abbreviation $^{(mul)}$A comes from.
27. Hunger and Steele, *op. cit.* (Note 7), p. 15.
28. O. Neugebauer and H.B. Van Hoesen, *Greek Horoscopes* (Philadelphia: The American Philosophical Society, 1959), pp. 22–3, p. 25. In this connection also see F. Boll, *Sphaera* (Leipzig: Teubner, 1903), p. 196, p. 389.
29. Euctemon, the author of the earliest known Greek *Parapegma*, who observed in Athens in 432 BC, did not yet know apparently the zodiacal constellations in full. However, the 12 zodiac constellations system was undoubtedly already well known to Eudoxus of Cnidus (first half of the fourth century BC). See D.R. Dicks, *Early Greek Astronomy to Aristotle* (Bristole: Thames and Hudson, 1970), p. 156f.; Kurtik, *op. cit.* (Note 1), pp. 80–1. There is a reason to believe that initially Greeks did not borrow the names of constellations from the Babylonians, but their symbols. When introducing their names for the zodiac constellations, they simply named the corresponding Mesopotamian symbols in Greek, see Kurtik, *op. cit.* (Note 1), pp. 102–3.
30. For its early publication as TE-Tafel see E. Weidner, *Handbuch der babylonischen Astronomie.* Bd. I (Leipzig: J.C. Hinrichs, 1915), pp. 121–2; for a modern publication see H. Hunger F.R. Stephenson, C.B.F. Walker, K.K.C. Yau, in: F.R. Stephenson and C.B.F. Walker (eds), *Halley's Comet in History* (L.: British Museum Publ., 1985), p. 15, p. 17. A high-quality photograph of the tablet may be found on the British Museum website, see <https://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=800758&partId=1&searchText=77824&page=1>. For a photo of the front side of the cuneiform tablet, see J.M. Steele, "A Comparison of Astronomical Terminology. . .," *Journal of Astronomical History and Heritage*, 16 (2013), 250–60, esp. 256, Fig. 2.
31. The Roman numerals in the text denote the month's names.
32. For schematic calendar see, for example, L. Brack-Bernsen, "The 360-Day Year in Mesopotamia," in: J.M. Steele (ed.), *Calendars and Years. Astronomy and Time in the Ancient Near East* (Oxford: Oxbow Books, 2007), pp. 83–100.
33. From recent publications, see G.E. Kurtik, "Geometry of the Mesopotamian 'ecliptic'," *Bulgarian Astronomical Journal*, 28 (2018), 37–41.
34. See Britton, *loc. cit.* (Note 22); Steele, *loc. cit.* (Note 1). It was previously assumed that mathematical zodiac appeared in Mesopotamia no later than in the middle of the fifth century BC. The basis for this assumption was the text BM 36599 (+ duplicates), known in modern literature as "S Text" (it was published in A. Aaboe and A. Sachs, "Two Lunar Texts of the Achaemenid Period from Babylon, *Centaurus*, 14 (1969), 1–22). It provides, in particular, calculated longitudes of the Sun and the Moon conjunctions for 38 assumed solar eclipses

from −474 to −456. In longitudes the following designations of zodiac signs are used: ḫun (Aries), mul_2 (Taurus), maš (Gemini), $alla_x$ (= $kušu_2$) (Cancer), A (Leo), $absin_0$ (= ki) (Virgo), rin_2 (Libra), gir_2 (Scorpio), pa (Sagittarius), $maš_2$ (Capricorn), gu (Aquarius), *zib* (Pisces). All of them are associated with constellations "in the path of the moon" in MUL.APIN.

J. Britton, however, showed that this text indeed was written much later, and could not have been composed before the end of the fifth century BC (after −401). He also analyzed the contents of the *Diaries* and concluded that the uniform zodiac was introduced between −408 and −397 not earlier, see Britton, *op. cit.* (Note 22), p. 645f. This discovery shifts the introduction of mathematical zodiac in Mesopotamian astronomy by about half a century.

35. See, for example, Brack-Bernsen, *op. cit.* (Note 1), p. 17.
36. See Sachs and Hunger, *loc. cit.* (Note 23); O. Neugebauer, *Astronomical Cuneiform Texts*. Vol. 1–3 (London: Lund Humphries, 1955).
37. For the use of GU_4, SIPA and $AŠ.GAN_2$ to denote respectively the second, third, and 12th signs of the zodiac see articles g31, s21, a48 in Kurtik, *loc. cit.* (Note 12). See also the detailed analysis of the history of designations of zodiacal signs in the texts of different types (*Astronomical diaries*, texts related to mathematical astronomy, and astrological texts) in the article by J. Steele, *op. cit.* (Note 1), p. 101–3.
38. *Late Babylonian Astronomical and Related Texts copied by T.G. Pinches and J.N. Strassmaier*. Prepared for publ. by A.J. Sachs (Providence: Brown Univ. Press, 1955). Transliteration and translation of the text: MUL_2.BABBAR *dele-bat* GU_4.UD GENNA AN / ḪUN MUL_2.MUL_2 MAŠ.MAŠ ALLA A / ABSIN RIN_2 GIR_2.TAB PA $MAŠ_2$ / GU *zib*^{me} "Jupiter, Venus, Mercury, Saturn, Mars, / Aries, Taurus, Gemini, Cancer, Leo, / Virgo, Libra, Scorpio, Sagittarius, Capricorn, / Aquarius, Pisces."
39. Steele, *op. cit.* (Note 1), p. 101.
40. For a publication of the text see A. Ungnad, "Besprechungskunst und Astrologie in Babylonien," *Archiv für Orientforschung*, 14 (1941–44), 251–84; see also its investigation in Reiner, *op. cit.* (Note 4), pp. 108–10. For a new edition and interpretation of the text see JoAnn Scurlock, "Sorcery in the Stars: STT 300, BRM 4.19–20 and the Mandaic Book of the Zodiac," *Archiv für Orientforschung*, 51 (2005–6), 125–146. For an electronic version of BRM 4.20 see also <http://oracc.museum.upenn.edu/cams/gkab/P296512> and literature mentioned there.
41. Researchers differ on this point: according to A. Ungnad, these are the names of constellations; according to JoAnn Scurlock, the designations of zodiac signs; see Ungnad, *op. cit.* (Note 40), pp. 256–8; Scurlock, *op. cit.* (Note 40), p. 127 *et al.*