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The use of the Xultun Lunar Table in the Lunar Series at Yaxchilan

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Abstracts

As is known, Yaxuun B'ahlam IV [1], also known as Bird Jaguar IV, acceded to the throne of Yaxchilan on 9.16.1.0.0 11 Ajaw 8 Sek (April 29, 752). This date marks the end of the first tun after k'atun ending at 9.16.0.0.0 [2]. This critical date is recorded on at least six monuments at Yaxchilán [3]. Interestingly, Stela 11 displays twice this accession date on the base panel and a lateral side. Curiously, the date of accession is followed by two different Lunar Series. The glyphic text carved on the lateral sides of Stela 11 indicates the lunar month of 30 days, whereas the text on the base panel bears 29 days (see Table 1). Teeple first described this peculiarity [4] as "double dates," ascribing those differences to the mechanism of correlating the recorded lunar month with the observed Moon. In other words, both lunar data may indicate that around 9.16.1.0.0 the Maya proceeded with intercalation.

In this paper I am applying the Lunar Table from Xultun as a lunar correction table to show that the Maya scribes could have used this mechanism to record the lunar motion during the 8th century CE at Yaxchilan.

Keywords: Yaxchilan Lunar Series; Xultun Lunar Table; Maya Astronomy

Introduction

Though the Maya did not use a formal lunar calendar like those in the ancient Near East and Mediterranean or China, they devised a complex system of recording lunar months known as the Lunar Series. They attached the Lunar Series to the Long Count date as part of the so- called Supplementary Series. The Lunar Series is the phrase that contains three to six glyphs, called E, D, C, X, B, and A, by Morley [5], bringing together information about the current lunar month (Glyphs E and D), the number of completed lunar months grouped in subsets of 6 and 18 differentiated months (Glyphs C and X), and the record whether the month, in turn, would be 29 or 30 days long. From the 5th century onwards, the Maya used the more or less regular sequence of the alternated 29- and 30-day months. In theory, the month began when the first lunar crescent was visible after conjunction, but it varied from site to site and time. In order to synchronize their calendar with the moon, they used schemes based on calculations. The evolution of the Lunar Series eventually led the installation of a fixed and standardized alternation of 29- and 30-day months grouped into the sets of 6 months each (177 days). Each such semester was patronized by one of the three distinct deity heads linked to Glyph C, identified with the Jaguar God of the Underworld (j), the Death God (s), and the Tonsured Maize God (m) see [6]. The numerical coefficient of Glyph C, and the variants of Glyph X determined particular months (see Table 1).

As is known, the 10K-2 Building at Xultun was where the scribes, called *taaj* [7], painted and incised various calendrical and astronomical computations. One of the texts, placed on the eastern wall, shows lunar tabulations; hence it is called a Lunar Table [8,9]. Its layout displays 27 columns, each forming 177- or 178-day intervals that equal to six schematic 29- and 30-day months, in total 4784 days (see Table 2). Atop the columns are glyphs representing three distinct deity heads, the Jaguar God of the Underworld, the Death God, and the Tonsured Maize God. The table aims to compute the lunar synodic period using a 4784-day interval [10]. The layout and structure of the Tables closely resemble the so-called Lunar Series, which often follows the Long Count dates placed on monuments.

In a Mayan lunar calendar, as described above, the Moon's age was loosely tied to the lunar phases. However, when alternating 29- and 30-day months were in use to synchronize the lunar calendar with the Moon, there was a need to intercalate extra days in the lunar calendar. Scholars long supposed that the Maya added an extra day to one of the 29-day months. The period during which the lunar movement reaches one day of difference to the fixed sequence of alternating 29- and 30-day month is about 964.4 days[1].

[1]It can be computed using the rule of three. The alternating 29- and 30-day months give an average length for a lunar month as 29.5 days, whereas the true lunar synodic month amounts to 29.53059 days. Therefore 29.5/0.03059 = 964.4 days. The lunar calendar and the mean Moon will differ by one day after 964.4 days.

Table 1: Numerical coefficients combined with the lunar patrons of Glyph C denote eighteen different lunar months of either 29 or 30 days each: s-skull (Death God), m – Tonsured Maize God, j - Jaguar God of the Underworld.

 **Group I**	 **Group II**	 **Group III**
1Cs 30	1cm 30	1Cj 30
2Cs 29	2cm 29	2Cj 29
3Cs 30	3cm 30	3Cj 30
4Cs 29	4cm 29	4Cj 29
5Cs 30	5cm 30	5Cj 30
6Cs 29	6cm 29	6Cj 29
6 lunar months = 177 days	6 lunar months = 177 days	6 lunar months = 177 days
18 lunar months = 531 days		

Table 2: Transcription of the calendrical count of the Xultun Lunar Table. Cumulative numbers 354 and 886 are not given in the table, they are included for the convenience of the reader to show the structure, as well as column numbers. Labels: J- Jaguar God of the Underworld, S – Skull, M – Tonsured Maize God.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
J	S	M	J	S	M	J	S	M	J	S	M	J	S	M	J	S	M	J	S	M	J	S	M	J	S	M
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	8	7	7	7	7	8	7	7	7	7	8	7	7	7	7	8	7	7	7	7	8
	354					886					886					886					886					886

The structure and number of days provided by the Xultun Lunar Table reveal its possible origins. First, we observe that 4784 = 9 x 531 plus 5 days, indicating five additional intercalary days within nine cycles of 531 days[2]. Naturally, each 531-day cycle consisted of an equal number of 29- and 30-day months, as 9 x 29 + 9 x 30 = 531 days. This equation is equal to 3 x 177 = 531, and finally, 9 x 59 = 531. These occurrences lead to the conclusion that the Maya derived the lunar count from the basic 59-day cycle (see [11]). Further considerations are, however, beyond the scope of the present paper.

The cyclic character of the Maya lunar reckoning is also visible in 531-day periods (3 x 6 lunar months). Each such cycle can be repeated endlessly, ascribing a fixed position to every lunar day (see Table 3). Furthermore, as 531 days is divisible by 9 (531 : 9 = 59), it can directly be associated with a sequence of nine glyphs labeled Glyphs G[3][12]. Putting it simply, matching the 9-day cycle with the cycle of 531 days permits fixing Glyphs G with particular lunar dates. After computing one cycle of 531 days, the same Lunar Series combines with the same Glyph G (see [13]) Adding a leap day to one of the 29-day months now converts a 531- day period into 532 days. Consequently, each period of 532 days shifts the Glyph G correlation by one day. Careful analysis of these shifts on a scale of 531 days allows us to deduce how many days the Maya added to the cycles of 531 days to correlate the regular lunar count with the actual Moon.

Interpretation of the Xultun Lunar Table suggests that the intercalation of an extra day was not only regular but also followed a fixed 4784-day cycle. Furthermore, this cycle was not a sudden invention but rather the result of a gradual process that began with the creation of Glyph A, which reported on whether the month was 29 or 30 days long. Establishing a standard or fixed system of alternating 29- and 30-day months enabled the Maya to predict the right moment to add an extra day. The Maya skywatchers could also design larger cycles composed of multiple 4784-day components to perform lunar computations back in time [14,15].

The Lunar Series at Yaxchilan

The information provided above should be enough to proceed with the analysis of the Lunar Series from Yaxchilan. The origins of the Classic period (ca. CE 250-900) kingdom of Yaxchilan can be traced to a ruler Yopaat B'ahlam I, who founded his dynasty in CE

[2]4784: 5 = 956.8 days. This value is compared with the one computed in note 1.

[3]Although Thompson [12] first demonstrated that Glyph G and Glyph F represented a recurring series corresponding to the Nine Lords of Central Mexico, their calendrical significance remains obscure. There are nine variants of Glyph G, labeled G1 through G9, representing a 9-day cycle recycled in endless succession. For more on this subject, see [13].

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320 [3]. The city, located along the Usumacinta river, reached the peak of its power under the reign of the two lords who lived in the Late Classic, Iztammnaah Kokaaj B'ahlam II (CE 681-742) and his son, Yaxuun B'ahlam IV (CE 752 - 768). The Lunar Series examined in this article comes from the monuments commissioned by both lords.

Yaxuun B'ahlam IV acceded to rulership on 9.16.1.0.0 11 Ajaw 8 Sek (Apr 28, 752 CE)[4], and this date is recorded on at least six monuments at Yaxchilán [3]. The texts on Stela 11 mention this date twice; in each case, different Lunar Series follow this date. Thus, the glyphic text carved on the lateral sides of Stela 11 indicates the lunar month of 30 days, whereas the text on the base panel carries 29 days (see Table 4). The difference between these data is that one date increases the number of days of a lunar month from 29 to 30. It is, therefore, plausible to suppose that different lunar data might suggest some intercalation [4].

In contrast with Teeple, however, the current reading of the numerical coefficients of Glyphs C indicates that it is the fifth month in both cases and not the fourth month in the front inscription (5C 29), as previously thought. This seems strange because in all cases where "double dates" occur, the difference is between the month's number and the month's length[5]. Be as it may be, I take these differences as a sign of some intercalation (Table 4).

One tun (360 days) before his accession, on 9.16.0.0.0 2 Ajaw 13 Tzek, on Altar 9, the Maya recorded another Lunar Series. The initial dates and the lunar data should be separated by 360 days (see Table 5). This period consists of two groups of 177 days plus the remaining six days (360 = 2 x 177 +6 days), or 354 days (= 6 x 30 + 6 x 29 days) days plus six days. Therefore, this operation explains the transition from 6D 5Cj 10 to 12D 5Cj 10 (Stela 11, side). On the other hand, the notation 12D 5Cm 9 placed on the Stela 11 front base panel calls for 30 days to be assigned to the previous month, 4Cj 10 since we rule out the possibility of two consecutive months with 29 days. However, by allocating 30 days to the preceding month, we break up with the symmetry of regularly alternating 29 and 30-day months. The formula of 354 + 6 = 360 days requires an equal number of 29- and 30-day months, while any intercalation produces the computation of 355 (= 7 x 30 + 5 x 29 days) plus five days. Thus, the notation 12D 5Cm 9 remains a mystery as things stand. To sum up, this operation shows that between 9.16.0.0.0 (751 CE) and 9.16.1.0.0 (752 CE), no intercalation succeeded (see Table 5). Only half of a year (183 days) later, on 9.16.1.9.3 (November 2, 752), Yaxuun B'ahlam IV commissioned Altar 3 (3), recording 17D 5Cj 10. This data will first be compared with the text from Altar 3 (Table 6) and then with Stela 11 (Table 7). So, at first, we observe that there are 543 days between 9.16.0.0.0 (Altar 9) and 9.16.1.9.3 (Altar 3).

Table 3: Positions of the lunar days in the cycle of 531 days. Explanation: Cs – skull (Death God A), Cm – Tonsured Maize God, j – Jaguar God of the Underworld.

Day, Month, Length, Position	Day, Month, Length, Position	Day, Month, Length, Position	Day, Month, Length, Position	Day, Month, Length, Position	Day, Month, Length, Position
1 1Cs 30 (1)	1 4Cs 29 (90)	1 1Cm 30 (178)	1 4Cm 29 (267)	1 1Cj 30 (355)	1 4Cj 29 (444)
2 1Cs 30 (2)	2 4Cs 29 (91)	2 1Cm 30 (179)	2 4Cm 29 (268)	2 1Cj 30 (356)	2 4Cj 29 (445)
3 1Cs 30 (3)	3 4Cs 29 (92)	3 1Cm 30 (180)	3 4Cm 29 (269)	3 1Cj 30 (357)	3 4Cj 29 (446)
4 1Cs 30 (4)	4 4Cs 29 (93)	4 1Cm 30 (181)	4 4Cm 29 (270)	4 1Cj 30 (358)	4 4Cj 29 (447)
5 1Cs 30 (5)	5 4Cs 29 (94)	5 1Cm 30 (182)	5 4Cm 29 (271)	5 1Cj 30 (359)	5 4Cj 29 (448)
6 1Cs 30 (6)	6 4Cs 29 (95)	6 1Cm 30 (183)	6 4Cm 29 (272)	6 1Cj 30 (360)	6 4Cj 29 (449)
7 1Cs 30 (7)	7 4Cs 29 (96)	7 1Cm 30 (184)	7 4Cm 29 (273)	7 1Cj 30 (361)	7 4Cj 29 (450)
8 1Cs 30 (8)	8 4Cs 29 (97)	8 1Cm 30 (185)	8 4Cm 29 (274)	8 1Cj 30 (362)	8 4Cj 29 (451)
9 1Cs 30 (9)	9 4Cs 29 (98)	9 1Cm 30 (186)	9 4Cm 29 (275)	9 1Cj 30 (363)	9 4Cj 29 (452)
10 1Cs 30(10)	10 4Cs 29 (99)	10 1Cm 30 (187)	10 4Cm 29 (276)	10 1Cj 30 (364)	10 4Cj 29 (453)
11 1Cs 30 (11)	11 4Cs 29 (100)	11 1Cm 30 (188)	11 4Cm 29 (277)	11 1Cj 30 (365)	11 4Cj 29 (454)
12 1Cs 30 (12)	12 4Cs 29 (101)	12 1Cm 30 (189)	12 4Cm 29 (278)	12 1Cj 30 (366)	12 4Cj 29 (455)

[4]In correlating Maya dates with the Julian calendar dates, I am using a correlation constant of 584283.

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13 1Cs 30(13)	13 4Cs 29 (102)	13 1Cm 30(190)	13 4Cm 29 (279)	13 1Cj 30 (367)	13 4Cj 29 (456)
14 1Cs 30 (14)	14 4Cs 29 (103)	14 1Cm 30 (191)	14 4Cm 29 (280)	14 1Cj 30 (368)	14 4Cj 29 (457)
15 1Cs 30 (15)	15 4Cs 29 (104)	15 1Cm 30 (192)	15 4Cm 29 (281)	15 1Cj 30 (369)	15 4Cj 29 (458)
16 1Cs 30 (16)	16 4Cs 29 (105)	16 1Cm 30 (193)	16 4Cm 29 (282)	16 1Cj 30 (370)	16 4Cj 29 (459)
17 1Cs 30 (17)	17 4Cs 29 (106)	17 1Cm 30 (194)	17 4Cm 29 (283)	17 1Cj 30 (371)	17 4Cj 29 (460)
18 1Cs 30(18)	18 4Cs 29 (107)	18 1Cm 30 (195)	18 4Cm 29 (284)	18 1Cj 30 (372)	18 4Cj 29 (461)
19 1Cs 30 (19)	19 4Cs 29 (108)	19 1Cm 30 (196)	19 4Cm 29 (285)	19 1Cj 30 (373)	19 4Cj 29 (462)
20 1Cs 30 (20)	20 4Cs 29 (109)	20 1Cm 30 (197)	20 4Cm 29 (286)	20 1Cj 30 (374)	20 4Cj 29 (463)
21 1Cs 30 (21)	21 4Cs 29 (110)	21 1Cm 30 (198)	21 4Cm 29 (287)	21 1Cj 30 (375)	21 4Cj 29 (464)
22 1Cs 30 (22)	22 4Cs 29 (111)	22 1Cm 30 (199)	22 4Cm 29 (288)	22 1Cj 30 (376)	22 4Cj 29 (465)
23 1Cs 30 (23)	23 4Cs 29 (112)	23 1Cm 30 (200)	23 4Cm 29 (289)	23 1Cj 30 (377)	23 4Cj 29 (466)
24 1Cs 30 (24)	24 4Cs 29 (113)	24 1Cm 30 (201)	24 4Cm 29 (290)	24 1Cj 30 (378)	24 4Cj 29 (467)
25 1Cs 30 (25)	25 4Cs 29 (114)	25 1Cm 30 (202)	25 4Cm 29 (291)	25 1Cj 30 (379)	25 4Cj 29 (468)
26 1Cs 30 (26)	26 4Cs 29 (115)	26 1Cm 30 (203)	26 4Cm 29 (292)	26 1Cj 30 (380)	26 4Cj 29 (469)
27 1Cs 30 (27)	27 4Cs 29 (116)	27 1Cm 30 (204)	27 4Cm 29 (293)	27 1Cj 30 (381)	27 4Cj 29 (470)
28 1Cs 30 (28)	28 4Cs 29 (117)	28 1Cm 30 (205)	28 4Cm 29 (294)	28 1Cj 30 (382)	28 4Cj 29 (471)
29 1Cs 30 (29)	29 4Cs 29 (118)	29 1Cm 30 (206)	29 4Cm 29 (295)	29 1Cj 30 (383)	29 4Cj 29 (472)
30 1Cs 30 (30)	1 5Cs 30 (119)	30 1Cm 30 (207)	1 5Cm 30 (296)	30 1Cj 30 (384)	1 5Cj 30 (473)
1 2Cs 29 (31)	2 5Cs 30 (120)	1 2Cm 29 (208)	2 5Cm 30 (297)	1 2Cj 29 (385)	2 5Cj 30 (474)
2 2Cs 29 (32)	3 5Cs 30 (121)	2 2Cm 29 (209)	3 5Cm 30 (298)	2 2Cj 29 (386)	3 5Cs 30 (475)
3 2Cs 29 (33)	4 5Cs 30 (122)	3 2Cm 29 (210)	4 5Cm 30 (299)	3 2Cj 29 (387)	4 5Cj 30 (476)
4 2Cs 29 (34)	5 5Cs 30 (123)	4 2Cm 29 (211)	5 5Cm 30 (300)	4 2Cj 29 (388)	5 5Cj 30 (477)
5 2Cs 29 (35)	6 5Cs 30 (124)	5 2Cm 29 (212)	6 5Cm 30 (301)	5 2Cj 29 (389)	6 5Cj 30 (478)
6 2Cs 29 (36)	7 5Cs 30 (125)	6 2Cm 29 (213)	7 5Cm 30 (302)	6 2Cj 29 (390)	7 5Cj 30 (479)
7 2Cs 29 (37)	8 5Cs 30 (126)	7 2Cm 29 (214)	8 5Cm 30 (303)	7 2Cj 29 (391)	8 5Cj 30 (480)
8 2Cs 29 (38)	9 5Cs 30 (127)	8 2Cm 29 (215)	9 5Cm 30 (304)	8 2Cj 29 (392)	9 5Cj 30 (481)
9 2Cs 29 (39)	10 5 1Cs 30 -128	9 2Cm 29 (216)	10 5 1Cm 30 -305	9 2Cj 29 (393)	10 5Cj 30 (482)

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10 2Cs 29 (40)	11 5Cs 30 (129)	10 2Cm 29 (217)	11 5Cm 30 (306)	10 2Cj 29 (394)	11 5Cj 30 (483)
11 2Cs 29 (41)	12 5Cs 30 (130)	11 2Cm 29 (218)	12 5Cm 30 (307)	11 2Cj 29 (395)	12 5Cj 30 (484)
12 2Cs 29 (42)	13 5Cs 30 (131)	12 2Cm 29 (219)	13 5Cm 30 (308)	12 2Cj 29 (396)	13 5Cj 30 (485)
13 2Cs 29 (43)	14 5Cs 30 (132)	13 2Cm 29 (220)	14 5Cm 30 (309)	13 2Cj 29 (397)	14 5Cj 30 (486)
14 2Cs 29 (44)	15 5Cs 30 (133)	14 2Cm 29 (221)	15 5Cm 30 (310)	14 2Cj 29 (398)	15 5Cj 30 (487)
15 2Cs 29 (45)	16 5Cs 30 (134)	15 2Cm 29 (222)	16 5Cm 30 (311)	15 2Cj 29 (399)	16 5Cj 30 (488)
16 2Cs 29 (46)	17 5Cs 30 (135)	16 2Cm 29 (223)	17 5Cm 30 (312)	16 2Cj 29 (400)	17 5Cj 30 (489)
17 2Cs 29 (47)	18 5Cs 30 (136)	17 2Cm 29 (224)	18 5Cm 30 (313)	17 2Cj 29 (401)	18 5Cj 30 (490)
18 2Cs 29(48)	19 5Cs 30 (137)	18 2Cm 29 (225)	19 5Cm 30 (314)	18 2Cj 29 (402)	19 5Cj 30 (491)
19 2Cs 29 (49)	20 5Cs 30 (138)	19 2Cm 30 (226)	20 5Cm 30 (315)	19 2Cj 29 (403)	20 5Cj 30 (492)
20 2Cs 29 (50)	21 5Cs 30 (139)	20 2Cm 29 (227)	21 5Cm 30 (316)	20 2Cj 29 (404)	21 5Cj 30 (493)
21 2Cs 29 (51)	22 5Cs 30 (140)	21 2Cm 29 (228)	22 5Cm 30 (317)	21 2Cj 29 (405)	22 5Cj 30 (494)
22 2Cs 29 (52)	23 5Cs 30 (141)	22 2Cm 29 (229)	23 5Cm 30 (318)	22 2Cj 29 (406)	23 5Cj 30 (495)
23 2Cs 29 (53)	24 5Cs 30 (142)	23 2Cm 29 (230)	24 5Cm 30 (319)	23 2Cj 29 (407)	24 5Cj 30 (496)
24 2Cs 29 (54)	25 5Cs 30 (143)	24 2Cm 29 (231)	25 5Cm 30 (320)	24 2Cj 29 (408)	25 5Cj 30 (497)
25 2Cs 29 (55)	26 5Cs 30 (144)	25 2Cm 29 (232)	26 5Cm 30 (321)	25 2Cj 29 (409)	26 5Cj 30 (498)
26 2Cs 29 (56)	27 5Cs 30 (145)	26 2Cm 29 (233)	27 5Cm 30 (322)	26 2Cj 29 (410)	27 5Cj 30 (499)
27 2Cs 29 (57)	28 5Cs 30 (146)	27 2Cm 29 (234)	28 5Cm 30 (323)	27 2Cj 29 (411)	28 5Cj 30 (500)
28 2Cs 29 (58)	29 5Cs 30 (147)	28 2Cm 29 (235)	29 5Cm 30 (324)	28 2Cj 29 (412)	29 5Cj 30 (501)
29 2Cs 29 (59)	30 5Cs 30 (148)	29 2Cm 29 (236)	30 5Cm 30 (325)	29 2Cs 29 (413)	30 5Cj 30 (502)
1 3Cs 30 (60)	1 6Cs 29 (149)	1 3Cm 30 (237)	1 6Cm 29 (326)	1 3Cj 30 (414)	1 6Cj 29 (503)
2 3Cs 30 (61)	2 6Cs 29 (150)	2 3Cm 30 (238)	2 6Cm 29 (327)	2 3Cj 30 (415)	2 6Cj 29 (504)
3 3Cs 30 (62)	3 6Cs 29 (151)	3 3Cm 30 (239)	3 6Cm 29 (328)	3 3Cj 30 (416)	3 6Cj 29 (505)
4 3Cs 30 (63)	4 6Cs 29 (152)	4 3Cm 30 (240)	4 6Cm 29 (329)	4 3Cj 30 (417)	4 6Cj 29 (506)
5 3Cs 30 (64)	5 6Cs 29 (153)	5 3Cm 30 (241)	5 6Cm 29 (330)	5 3Cj 30 (418)	5 6Cj 29 (507)
6 3Cs 30 (65)	6 6Cs 29 (154)	6 3Cm 30 (242)	6 6Cm 29 (331)	6 3Cj 30 (419)	6 6Cj 29 (508)
7 3Cs 30 (66)	7 6Cs 29 (155)	7 3Cm 30 (243)	7 6Cm 29 (332)	7 3Cj 30 (420)	7 6Cj 29 (509)

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8 3Cs 30 (67)	8 6Cs 29 (156)	8 3Cm 30 (244)	8 6Cm 29 (333)	8 3Cj 30 (421)	8 6Cj 29 (510)
9 3Cs 30 (68)	9 6Cs 29 (157)	9 3Cm 30 (245)	9 6Cm 29 (334)	9 3Cj 30 (422)	9 6Cj 29 (511)
10 1Cs 30 (69)	10 6Cs 29 (158)	10 1Cm 30 (246)	10 6Cm 29 (335)	10 1Cj 30 (423)	10 6Cj 29 (512)
11 3Cs 30 (70)	11 6Cs 29 (159)	11 3Cm 30 (247)	11 6Cm 29 (336)	11 3Cj 30 (424)	11 6Cj 29 (513)
12 3Cs 30 (71)	12 6Cs 29 (160)	12 3Cm 30 (248)	12 6Cm 29 (337)	12 3Cj 30 (425)	12 6Cj 29 (514)
13 3Cs 30(72)	13 6Cs 29 (161)	13 3Cm 30 (249)	13 6Cm 29 (338)	13 3Cj 30 (426)	13 6Cj 29 (515)
14 3Cs 30 (73)	14 6Cs 29 (162)	14 3Cm 30 (250)	14 6Cm 29 (339)	14 3Cj 30 (427)	14 6Cj 29 (516)
15 3Cs 30 (74)	15 6Cs 29 (163)	15 3Cm 30 (251)	15 6Cm 29 (340)	15 3Cj 30 (428)	15 6Cj 29 (517)
16 3Cs 30 (75)	16 6Cs 29 (164)	16 3Cm 30 (252)	16 6Cm 29 (341)	16 3Cj 30 (429)	16 6Cj 29 (518)
17 3Cs 30 (76)	17 6Cs 29 165)	17 3Cm 30 (253)	17 6Cm 29 (342)	17 3Cj 30 (430)	17 6Cj 29 (519)
18 3Cs 30(77)	18 6Cs 29 (166)	18 3Cm 30 (254)	18 6Cm 29 (343)	18 3Cj 30(431)	18 6Cj 29 (520)
19 3Cs 30 (78)	19 6Cs 29 (167)	19 3Cm 30 (255)	19 6Cm 29 (344)	19 3Cj 30 (432)	19 6Cj 29 (521)
20 3Cs 30 (79)	20 6Cs 29 (168)	20 3Cm 30 (256)	20 6Cm 29 (345)	20 3Cj 30 (433)	20 6Cj 29 (522)
21 3Cs 30 (80)	21 6Cs 29 (169)	21 3Cm 30 (257)	21 6Cm 29 (346)	21 3Cj 30 (434)	21 6Cj 29 (523)
22 3Cs 30 (81)	22 6Cs 29 (170)	22 3Cm 30 (258)	22 6Cm 29 (347)	22 3Cj 30 (435)	22 6Cj 29 (524)
23 3Cs 30 (82)	23 6Cs 29 (171)	23 3Cm 30 (259)	23 6Cm 29 (348)	23 3Cj 30 (436)	23 6Cj 29 (525)
24 3Cs 30 (83)	24 6Cs 29 (172)	24 3Cm 30 (260)	24 6Cm29 (349)	24 3Cj 30 (437)	24 6Cj 29 (526)
25 3Cs 30 (84)	25 6Cs 29 (173)	25 3Cm 30 (261)	25 6Cm 29 (350)	25 3Cj 30 (438)	25 6Cj 29 (527)
26 3Cs 30 (85)	26 6Cs 29 (174)	26 3Cm 30 (262)	26 6Cm 29 (351)	26 3Cj 30 (439)	26 6Cj 29 (528)
27 3Cs 30 (86)	27 6Cs 29 (175)	27 3Cm 30 (263)	27 6Cm 29 (352)	27 3Cj 30 (440)	27 6Cj 29 (529)
28 3Cs 30 (87)	28 6Cs 29 (176)	28 3Cm 30 (264)	28 6Cm 29 (353)	28 3Cj 30 (441)	28 6Cj 29 (530)
29 3Cs 30 (88)	29 6Cs 29 (177)	29 3Cm 30 (265)	29 6Cm 29 (354)	29 3Cj 30 (442)	29 6Cj 29 (531)
30 3Cs 30 (89)		30 3Cm 30 (266)		30 3Cj 30 (443)	

Table 4: The lunar data on Stela 11.

Monument	Long Count/ number of days	Calendar Round	Other glyphs	Lunar Series	Event
Stela 11 front base panel	9.16.1.0.0 1411560	11 Ajaw 8 Sek	G9/F	12D 5Cj 9 [307]	Accession of Bird Jaguar IV
Stela 11 lateral side	9.16.1.0.0 1411560	11 Ajaw 8 Sek	G9/F	12D 5Cj 10 [307]	Accession of Bird Jaguar IV

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Table 5: Lunar computations between 9.16.0.0.0 (Altar 9) and 9.16.1.0.0 (Stela 11).

Monument	IS Date	Difference	LS	Difference	Computation
Altar 9	9.16.0.0.0 1411200	360	6D 5Cj 10 [1/478]	478 + 360 = 307	6D 5Cj 10 + 177 = 6D 5Cs 10 + 177 = 6D 5Cj 10 + 6 = 12D 5Cm 10
Stela 11 side	9.16.1.0.0 1411560		12D 5Cm 10 [307]		
Altar 9	9.16.0.0.0 1411200	360	6D 5Cj 10 [1/478]	478 + 360 = 307	6D 5Cj 10 + 177 = 6D 5Cs 10 + 177 = 6D 5Cj 10 + 6 = 12D 5Cm 9
Stela 1 front	9.16.1.0.0 1411560		12D 5Cm 10 [307]		

Table 6: Lunar computations between 9.16.0.0.0 (Altar 9) and 9.16.1.9.3 (Altar 3).

Monument	IS Date	Difference	LS	Difference	Computation
Altar 9	9.16.0.0.0 1411200	543	6D 5Cj 10 [1/478]	478 + 543 = 490	6D 5Cj 10 + 2 x 177 = 6D 5Cm 10 + 178 = 6 5Cj 10 + 11 = 17D 5Cj 10
Stela 11 side	9.16.1.9.3 1411743		17D 5Cj 10 [489]		

Table 7: Lunar computations between 9.16.1.0.0 (Stela 11) and 9.16.1.9.3 (Altar 3).

Monument	IS Date	Difference	LS	Difference	computation
Stela 11 side	9.16.1.0.0 1411560	183	12D 5Cm 10 [307]	307 + 183 =490	12D 5Cm 10 + 178 = 12D 5Cj 10 + 5 = 17D 5Cj 10
Altar 3	9.16.1.9.3 1411743		17D 5Cj 10[489]		
Stela 11 front	9.16.1.0.0 1411560	183	12D 5Cm 9[307]	307 + 183 =490	12D 5Cm 9 +178 = 12D 5Cj10 + 5 = 17D5Cj 10
Altar 3	9.16.1.9.3 1411743		17D 5Cj 10[489]		

The interval of 543 days is equivalent to a period of 531 days plus 12 days; therefore, it is enough to add 12 days to the date of Altar 9. However, the Maya recorded 17D 5Cj 10, one day less than expected. Indeed, the number of 531 days requires the formal 29- and 30-day lunar months, repeating in regular sequence. Nevertheless, this is not an error; on the contrary, it indicates that one intercalation was performed, that is, one cycle of 532 days plus 11 days (10 x 30 + 8 x 29 + 11, or 2 x 177 + 178 + 11 days). Now, we can add 11 days to 6D 5Cj 10 to arrive at 17D 5Cj 10. Note that the calculation mode in Table 6 confirms the information already obtained in Table 5; thus, from 6D 5Cj 10 to 17D 5Cj 10, the Maya computed 177 + 177 + 178 + 11 days.

The last step of our reconstruction compares the lunar dates on Stela 11 and Altar 3. This operation will ensure us that the Maya placed intercalation in the third semester between 6D 5Cj 10 and 17D 5Cj 10. The results of such computations are shown in Table 7.

Both dates in question stay 183 days apart. The regular lunar reckoning requires 177 + 6 days; the intercalation demands 178 + 5 days. In this case, the data from Table 7 are unambiguous and imply a completed intercalation. Therefore, the Lunar Series on Stela 11 finds the following explanation. The information displayed on the lateral side (12D 5Cm 10) proposes that after 5Cm 30 comes the month 6Cm 30, followed by the month 1Cj 30. And then, the sequence is regular: 2Cm 29, 3Cm 30, 4Cm 29, 5Cm 30. It, therefore, assigns the intercalation to the semester "m". The second option allocates the intercalation to the semester "j", 5Cm 30, 6Cm 29, 1Cj 30, 2Cj 30, 3Cj 30 4Cj 29, or 5Cm 30, 6Cm 29, 1Cj 30, 2Cj 29, 3Cj 30, 4Cj 30; it is always 178 + 5 days.

The matter is more straightforward, starting with the second Lunar Series placed on the base panel (12D 5Cm 9). The intercalation can only be assigned to semester "j". However, to intercalate, the following strategy is needed, after 5Cm 9 comes 6Cm 10. Then there are 1Cj 30, 2Cj 30, 3Cj 30, and 4Cj 29, but it is impossible to count four consecutive months of 30 days. Therefore, the viable solution will be: 5Cm 9, 6Cm 30, 1Cj 30, 2Cj 29, 3Cj 30, 4Cj 30, and 5Cj 30, implying a series of 3 consecutive months of 30 days each. This arrangement still needs to explain why the Maya wrote the month 5Cj 9. Another disadvantage of this procedure is that it uses twice a sequence of consecutive 30-day

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months. Given these problems, this notation must be provided with a clear explanation. I will not consider this notation later in this article.

Despite these ambiguities, the data analysis allows us to conclude that intercalation occurred between 9.16.0.0.0 6D 5Cj 10 (Altar 9) and 9.16.1.9.3 17D 5Cj 10 Altar [22], the sequence of months was 177, 177, and 178 days. The problem is whether the intercalation fell on semester "m" or "j". To solve this enigma, larger intervals of time are needed. Since intercalation takes place every 886 days, roughly 2.5 tuns, it is advisable to use larger time units to incorporate two 177-day intervals that dwell in the first two columns of the Xultun Lunar Table (see Table 2). This should allow us to infer which of the two semesters ("m" or "j") was intercalary.

This long-time distance offers Dintel 56. Its Initial Series reads 9.15.6.13.1, and the Lunar Series 11D 5Cj 10. Interestingly, the difference between the Initial Series dates displayed on Dintel 56 and Altar 9 yields 4779 days. This number is practically one Xultun Lunar Table cycle (consult Table 2). If we add five days to the Lunar Series on Altar 9, the Moon age will reach 11 days, as is recorded on Lintel 56. The structure of the Xultun Lunar Table requires a series of 354 plus 5 x 886 days, where each cycle of 886 days indicates intercalation see (Table 2). It means that between 9.15.6.13.1 and 9.16.0.0.0, the Maya made five intercalations. Now by adding five days to the interval of 4779 days, one reaches 4784 days, an entire Xultun Lunar Table cycle. Adding five days to the data on Altar 9 brings 11D 5Cj 10 on 9.16.0.0.5. Thus, from 9.15.6.13.1 to 9.16.0.0.5 are 4784 days, and we move between the same lunar data, i.e., 11D 5Cj 10. We have already concluded that the next intercalation happened between 9.16.1.0.0 and 9.16.1.9.3, either in the "m" or the "j" semester. Applying the Xultun Lunar Table to the Lunar Series on Stela 11 and Altar 22 shows that intercalation happened in the "m" semester. Based on this conclusion, we can confirm that another intercalation occurred in the semester "m ", literally a month and a half after Yaxuun B'ahlam ascended to the throne. This result may also be confirmed if we use the lunar data displayed on the monuments erected after 9.16.1.9.3. For example, Table 9 calculates the data that transpired between the erection of Altar 3 (9.16.1.9.3) and Stela 1 (9.16.0.0.0). Table 9 shows that the span between these two dates is 3057 days. Therefore, lunar calculations suggest that there were three intercalations during this period. Since this period consists of 14 periods of 177 days and 3 three periods of 178 days, using the Xultun table structure[6], we have three units of 886 plus 354 plus 45 days.

Table 8: Lunar computations between 9.15.6.13.1 (Lintel 56) and 9.16.0.0.0 (Altar 9).

Monument	IS Date	Difference	LS	Difference	computation
Lintel 56	9.15.6.13.1 1406421	4779	11D 5Cj 10 6/483]	483 + 4779 = 5262 – 9x531= 6/483 [11 5Cj]	4779 = 9 x 531 = 27 x 177= 81 x 59
Altar 9	9.16.0.0.0 1411200		6D 5Cj 10 [1/478]		4779 = 5 x 178 + 21 x 177+ 172 = 5 x 886 + 177 + 172

Table 9: Lunar computations between 9.16.1.9.3 (Altar 3) and 9.16.10.0.0 (Stela 1).

Monument	IS Date	Difference	LS	Difference	computation
Altar 3	9.16.1.9.3 1411743	3057	17D 5Cj 10[489]	489 + 3057 = 3546 -6x531 = 360 [6Cj 10]	3057 = (14 x 177 + 3 x 178) + 30 +15
Stela 1	9.16.10.0.0 1414800		3D[7] 1Cj 10[360]		3057 = 3 x 886 + 354 + 30 + 15

Three tuns later, on 9.16.13.0.0, Yaxuun B'ahlam dedicated his own dwelling, or Structure 10. The Initial Series date reads 9.13.17.12.10, his birthdate, but a series of distance numbers take us to 9.16.13.0.0 (764 CE). The lunar record is given for the first date, whereas we lack any reference to the lunar data on the later one. However, based on the above reconstructions, we can find the Lunar Series on 9.16.13.0.0. First, we calculate the data from the text on Stela 1 (Table 10). The difference between both dates is 1080 days, which is long enough to allow for one intercalation. Therefore, it is probable that on 9.16.13.0.0 fell 20D 1Cj 10.

Table 10: Lunar computations between 9.16.10.0.0 (Stela 1) and 9.16.13.0.0 (Lintel 29).

Monument	IS Date	Difference	LS	Difference	computation
Stela 1	9.16.10.0.0 1414800	1080	3D 1Cj 10 [6/357]	357 + 1080 =1437 – 2x531= 375 [21 1Cj]	1080 = 6 x177 + 18
Lintel 29	9.16.13.0.0 1415880		[20D 1Cj 10, 5/374]		886 +177 + 17= 20D 1Cj

[5]Following Morley [5,16], Teeple [4] read the lunar data as 12D 5C and 12D 4C. Later reexamining this text by Linda Schele and Peter Matthews showed that the Maya recorded the same Glyph C coefficients in both cases, i.e., 5C. This change is already reflected by Linden [17] and Schele et al. [18]. Though Linden [19] (Table 2) retracted an earlier reading of the coefficient five on Glyph C on the front of Stela 11, the recent Lunar Series readings [20, 21] confirmed that the Maya recorded 5Cm in both cases. So, for the Long Count date of 9.16.1.0.0, the Maya recorded 12D 5Cm 9 on the base front of Stela 11, whereas on its lateral side, they recorded 12D 5Cm 10.

[6]Observe that each unit of 886 days consists of 4 x 177 days plus 178 days.

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The second step is to calculate the lunar date of 9.16.13.0.0 from 9.13.17.12.10. The result is shown in Table 11. Both dates are separated by 19910 days. Observing that there are four periods of 4784 days within this period, we deduce there were 20 intercalations made. The result agrees with our reconstructed lunar data on 9.16.13.0.0. The last Lunar Series analyzed in this article refers to the information shown in Lintel 21. As is known, Lintel 21 comes from Structure 22, a monument erected by known, Jatz'o'm Jol during the Early Classic (1). The text commemorates the dedication of a house made by this dynastic ancestor on 9.0.19.2.4 (454 CE), and Yaxuun B'ahlam participates in a similar ritual in 9.16.1.0.9, nine days after his enthronement. The former date is accompanied by the Lunar Series, whereas the former has no data. However, we can use the data from Stela 11. Thus, 12D 5Cm 10 + 9 = 21D 5Cm 10. We can proceed with another lunar computation (see Table 12).

As can be caught from Table 12, for some unknown reason, the Maya calculated only 111 intercalations instead of the expected 113. Thus, when calculating lunar data from 9.16.1.0.9, they obtained 7D 3Cs 9 instead of the correct 9D 3Cs 9 result. So, counting backward, the period over 297 produced an error of 2 days. Unfortunately, at the moment, it seems impossible to explain the sources of this error. The distance number explicitly gives the number of days separating both dates, 108685 or 297 x 365 + 280 days or 301 x 360 + 325 days. Though the number seems to not represent any significant lunar number, it is equal to 22 x 4784 + 3437 days or 9 x 11960 + 1045 days.

Table 11: Lunar computations on Lintel 29.

Monument	IS Date	Difference	LS	Difference	computation
Lintel 29	9.13.17.12.10 1395970	19910	15D 5Cs 10 [7/133]	133 + 19910 = 20043 – 37 x 531 = 396 [12 2Cj]	19910 = 92 x 177 + 20 x 178 + 66
	9.16.13.0.0 1415880		[20D 1Cj 10, 6/374]		(20 x 886 + 8 x 177) + 4 x 177 + 66

Table 12: Lunar reckoning on Lintel 21 from a reconstructed date on 9.16.1.0.9.

Monument	IS Date	Difference	LS	Difference	computation
Lintel 21	9.0.19.2.4 1302884	108685	7D 3Cs 9[3/66]	66 + 108685 = 108751 -204x531 = 4/427 [14 3Cj]	108685 = 500 x 177 + 113 x 178 + 71
Lintel 21	9.16.1.0.9 1411569		[21 5Cm 10] [1/316]		111 x 886 + 58 x 177 + 73, [113 x 886 + 48 x 177 + 71], [9 D 3Cs 9]

Conclusion

It is possible to insert the Xultun Lunar Table onto Yaxchilan inscriptions (see Tables 13 & 14). Now, it can easily be proven that at least between 9.15.6.0.0 (731 CE) y 9.16.13.0.0.0 (764 CE), the Maya at Yaxchilan not only used the Xultun Lunar Table but also adopted the exact structure of lunar reckoning as in Xultun. They also used its structure to calculate the Moon back in deep time within this period.

Table 13: The recycling of the Xultun Lunar Table over Yaxchilan dates. Each column contains six lunar months numbered from 1 to 6, or 177 days. Each column is governed by one of the three "patrons": s-skull (Death God), m – Tonsured Maize God, j - Jaguar God of the Underworld. With "x," intercalations are denoted, following the scheme of the Xultun Lunar Table. Double "x" denotes the start/end of a revolving 4784-day cycle. In bold and italic recorded are the months falling on tun endings (= 360-day periods). As tun spans are bigger than twelve lunar month periods, these dates wander over the lunar months. These months can be juxtaposed with specific dates in Table 14.

s	m
1C	1C
2C	2C
3C	3C
4C	4C
5C	5C
6C	6C
	xx

[7]The Moon Age of 3 days is to be read after Morley [16].

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j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m
1C	1C	1C	1C	1C	1C	1C	1C	1C	***1C***	1C	***1C***	1C	***1C***	1C	***1C***	1C	***1C***	1C	1C	1C	1C	1C	1C	1C	1C	1C
2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	***2C***	2C	***2C***	2C	***2C***	2C	***2C***	2C
3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C
4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C
5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C
6C	6C	***6C***	6C	***6C***	6C	***6C***	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C
						x					x					x					x					xx

j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m
1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C
2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C
3C	3C	***3C***	3C	***3C***	3C	***3C***	3C	***3C***	3C	***3C***	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C
4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	***4C***	4C	***4C***	4C	***4C***	4C	***4C***	4C	***4C***	4C	***4C***	4C	4C	4C	4C
5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	***5C***	5C	***5C***
6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C
						x					x					x					x					xx

j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m	j	s	m
1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	***1C***	1C	***1C***	1C	***1C***	1C	***1C***	1C	***1C***
2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C
3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C
4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C	4C
5C	***5C***	5C	***5C***	5C	***5C***	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C
6C	6C	6C	6C	6C	6C	6C	***6C***	6C	***6C***	6C	***6C***	6C	***6C***	6C	***6C***	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C
						x					x					x					x					xx

j	s
1C	1C
2C	***2C***
3C	3C
4C	4C
5C	5C
6C	6C

Table 14: Hypothetical Lunar Series computed at tun-endings at Yaxchilan. Those tun-endings correspond to “x” marks in Table 13.

Long Count Date	Lunar Series Date
9.16.15.0.0	1D 2Cs 9 [31]
9.16.14.0.0	26D 1Cm 10 [203]
9.16.13.0.0	20D 1Cj 10 [374]
9.16.12.0.0	14D 1Cs 10 [14]
9.16.11.0.0	9D 1Cm 10 [186]
9.16.10.0.0	3D 1Cj 10 [357]
9.16.9.0.0	27D 6Cj 9 [529]
9.16.8.0.0	21D 6Cs 9 [169]
9.16.7.0.0	16D 6Cm 9 [341]
9.16.6.0.0	10 6Cj 9 [512]
9.16.5.0.0	4D 6Cs 9 [152]

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9.16.4.0.0	29D 5Cm 10 [324]
9.16.3.0.0	23D 5Cj 10 [496]
9.16.2.0.0	17D 5Cs 10 [135]
9.16.1.0.0	12D 5Cm 10 [307]
9.16.0.0.0	6D 5Cj 10 [478]
9.15.19.0.0	29D 4Cs 9 [118]
9.15.18.0.0	24D 4Cm 9 [290]
9.15.17.0.0	18D 4Cj 9 [461]
9.15.16.0.0	13D 4Cs 9 [102]
9.15.15.0.0	7D 4Cm 9 [273]
9.15.14.0.0	1D 4Cj 9 [444]
9.15.13.0.0	26D 3Cs 10 [85]
9.15.12.0.0	20D 3Cm 10 [256]
9.15.11.0.0	15D 3Cj 10 [428]
9.15.10.0.0	9D 3Cs 10 [68]
9.15.9.0.0	3D 3Cm 10 [239]
9.15.8.0.0	26D 2Cj 9 [410]
9.15.7.0.0	21D 2Cs 9 [51]
9.15.6.0.0	15D 2Cm 9 [222]
9.15.5.0.0	10D 2Cj 9 [394]

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