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Hector Santos

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One of the most interesting things in the Laguna Copperplate Inscription (LCI) that Antoon Postma revealed to the world when he deciphered the document was its date. As he pointed out, it pushes back the window of Philippine history some six hundred years or so, albeit with a big gap that needs to be filled in. This is a big challenge to historians who may have to come up with new and imaginative ways to make the record complete and seamless from the new starting point to 1521 when records become available again.

The LCI Date

The date of the LCI is contained in its first line, the last word carrying on to the second line:

> swasti śaka warṣātīta 822 waisākha māsa ding jyotiṣa / caturthi kṛṣṇapakṣa somāwara

Postma (1991, 12) translates the above as follows:

> Hail! In the Saka-year 822; the month of March-April; according to the astronomer: the 4th day of the dark half of the moon; on Monday.

I would translate it basically the same but would reword it differently:

> Greetings! Shaka year 822, month of Waisakha according to the stars, fourth day of the waning moon, Monday.

At first glance, the determination of a Julian equivalent of the date seems easy enough but, for some reason, nobody has come up with a date yet. I decided to tackle the problem and it turned out to be not as trivial as it seemed. It involved the reconstruction of an ancient calendar used in the Philippines over a millennium ago using clues provided by Indian and Indonesian calendars from which it was derived.

Let me present the answer right at the start. Then I will show how this equivalent date was derived. The Julian equivalent is:

Monday, 21 April 900 A.D.

At this point, let me state that there are references by Casparis (1978, 47–48) and Chakravarty (1975, 46) to tables published by Sewell and Dikshit in 1896 and by van Wijk in 1924 that reportedly give information for converting Indian calendar dates to Julian dates. Casparis, in particular, suggests using the tables to prevent computational errors from happening.

There are three good reasons for determining the date from scratch and not using the suggested tables. Use of the tables can actually lead to errors instead of preventing them from happening.

First, the published tables were computed for India. Applying such data indiscriminately to Indonesia and the Philippines could result in errors. Because a new moon occurs simultaneously throughout the world and there is a three-hour difference in local time between India and the Philippines, the computed time of the new moon may fall on different dates. More importantly, the new moon may occur before sunrise in India, but after sunrise in the Philippines, making a difference in the day count as I will explain later.

Secondly, the computation of new moons, full moons, and other celestial phenomena for dates over a millennium ago involves errors. We have better correction factors available today than we did a century ago. Chakravarty (1975, 46) even states that the Dikshit tables were based on K.L. Chatre's earlier tables published in Poona in 1851, which in turn were based on still earlier European tables by Delambre and others.

The margin of error using present-day techniques is now down to about a few minutes. I have no idea what it was for the tables mentioned above, but they were manually computed with the help of logarithmic tables, thus susceptible to a lot of errors.

My astronomer-friends wonder why historians insist on using old lunar tables for determining new moons when more accurate methods are available today. I tell them that historians feel more comfortable using tools they've already seen in journals because if they are proved to be wrong later, somebody else must have been wrong earlier.

Thirdly, the above mentioned tables according to accounts (Chakravarty 1975, 52 ff.) were based on the modern sūrya siddhānta which took effect during the late tenth century A.D. in India. At that time the use of mean motions of the heavenly bodies was replaced by their true motions. Naturally, such a reform would not have been in effect yet in the Philippines or Indonesia in 900. Chakravarty has shown that the differences between the two systems can be considerable.

The Philippine Calendar

Let us now examine the Indian calendar as it relates to the one introduced into the Philippines. I will limit my discussion to the relevant components that appear on the LCI. I will discuss in turn the length and the starting point of a year, the names and the length of a month, the "half of the moon" submonth, the numbered dates, and the days of the week.

There is a dearth of material on Indian and Indonesian calendars. (None is available for ancient Philippine calendars because its discovery was fairly recent.) The few that are available are sometimes contradictory and one even contains many errors. Some were written by good historians with inadequate mathematical or astronomical knowledge.

Where there is a conflict in written source materials, I give preference to Chakravarty (1975) over Basham (1954) and Casparis (1978). Basham's material is not detailed enough and Casparis's explanation of calendrical information contains some errors.

The Indian year is a variable length year based on lunar months. Since its nominal length of twelve lunar months (māsa) or 354.37 days is shorter than that of a solar year of 365.25 days by 10.88 days, it is periodically corrected to keep in step with the solar year.

In the system that was established in Indonesia and the Philippines, the year begins and ends with the first new moon after the sun enters the sign of Pisces according to Casparis (1978, 8). Chakravarty says that the year starts with the first new moon prior to the vernal equinox (1975, 35–36). The first day of the year is actually the next day after whatever new moon marker is used.

These two new moons of Casparis and Chakravarty do not necessarily coincide. Occasionally, two new moons will fit between the time the sun enters Pisces and the vernal equinox because it takes the sun 30.44 days to traverse the 30 degrees between these two points while a lunar cycle, on the average, is only 29.53 days.

Depending on how soon the first new moon occurs after the sun enters Pisces, it is also possible to fit in thirteen lunar months until the sun's next entry into Pisces. Most years would have twelve lunar months but there would be a thirteen-month year every two or three years.

Just what exactly does "the sun enters the sign of Pisces" mean? Two thousand years ago, the Greeks and other cultures in the Mediterranean divided the skies along the path of the sun into twelve equal zones, each named for the star constellation that was prominent in that zone. This was called the zodiac and is the band along the path of the sun extending approximately thirty degrees on each side.

At that time, the constellations coincided with the zones and the start of the measurement was at the point where the sun crossed from the south of the ecliptic to the north. That point marked the vernal equinox or the time Winter turned to Spring.

However, because of the phenomenon called "precession," the constellations have moved west in relation to the vernal equinox. The sign of Aries which represents the area from zero to thirty degrees now no longer coincides with the location of the constellation Aries. Today, the stars have shifted 15.3 degrees from where they were in 900 A.D. and almost 30 degrees from their location 2000 years ago.

Whereas the vernal equinox was considered to be at the point where the sun entered Aries two thousand years ago, it now occurs in the constellation Pisces. However, the astrological signs moved with the vernal equinox and are now just imaginary zones in the ecliptic relative to the vernal equinox. The Indians adopted this system and the names of the signs are literal or exact translations of their Greek originals (Basham 1954, 493). So when we say "the sun enters Pisces," we mean the time in which the sun reaches 330 degrees (the sign Pisces is located 330–360 degrees) in the ecliptic and has nothing to do with the constellation at all.

The Indian signs and their respective Western equivalents are as follows:

meşa	Aries
vrişabha	Taurus

mithuna	Gemini
karkaṭa	Cancer
ṣiṃha	Leo
kanyā	Virgo
tulā	Libra
vriśchika	Scorpio
dhanus	Sagittarius
makara	Capricorn
kumbha	Aquarius
mīna	Pisces

There were many ways of numbering years during different eras but the only system that reached Southeast Asia was the one used to mark the śaka *(Shaka)* era. The era's origin is still not clear but it started in 78 A.D. In most cases, the *Shaka* year cited was the elapsed instead of the current year, but this was not necessarily true for all Indian systems. In any case, we will assume that the elapsed year count was used in the Philippines. Thus, 78 A.D. was Year 0, not Year 1. To convert from *Shaka* years to Christian years, we add 78, instead of 77, to the *Shaka* count.

The ancient Filipinos probably determined new moons through computation rather than from observation as was customary in the Islamic system. The true new moon is unobservable, its first crescent only becoming visible ten to sixteen hours after the true new moon.

A lunar cycle is variable and is complicated by many factors that determine its apparent path. This makes computations fairly complex and we are actually in a better position today to compute ancient lunar phases than the people of long ago.

Although we do not know exactly how they computed their lunar cycles, we know that they used a mean moon that travelled at a specified rate along a specified path. The sophisticated concept of true moon motion did not become available until the late 10th century.

The names of the lunar months are:

caitra	asuji
waiśākha	kārttika
jyeṣṭha	mārgaśira
āṣāḍha	poṣya
śrāwaṇa	māgha
bhadrawāda	phālguṇa

In the LCI waiśākha *(waishakha)* is spelled waisākha *(waisakha)*, which could be an indication of its local pronunciation.

Casparis states that any of the twelve months can be doubled during a thirteen-month year and act as a leap month (1978, 8). However, Basham claims that only āṣāḍha and śrāwana may act as leap months (1954, 492). Perhaps, Indonesian practice was different from Indian practice in this instance.

Whatever the true story is, the leap month is called "second (dwitīya) month name." It may appear that Chakravarty supports Casparis in this discrepancy (Chakravarty 1975, 42–45) but his discussion was limited to modern sūrya siddhānta which did not take effect till late tenth century in India, too late to have had any effect in 900 A.D. Philippines.

Each month is divided into two halves, the bright half śuklapakṣa *(shuklapaksha)* and the dark half kṛṣṇapakṣa *(krishnapaksha)* of the moon. They represent the waxing (new moon to full moon) and waning (full moon to new moon) phases of the moon, respectively. The half of the moon is what we know as a fortnight.

Although most writers have said that the basic unit of the Indian calendar was a "lunar day" (tithi) which was 1/30th of a lunar month, it is not the whole truth. Since a lunar month is 29.531 days or 708.744 hours, a tithi is 0.984 day or 23.625 hours, 22.5 minutes short of a solar day.

Each half of the moon or pakṣa *(paksha)* has 15 tithi that are numbered from 1 to 15. The tithi are named (numbered) as follows:

pratipāda	1	nawamī	9
dwitīyā	2	daśami	10
tritīyā	3	ekādaśī	11
caturthī	4	dwādaśī	12
pañcamī	5	trayodaśī	13
ṣaṣṭī	6	caturdaśī	14
saptamī	7	pañcadaśī	15
aṣṭamī	8		

The mismatch between the length of a tithi and that of a solar day causes another problem. Since a lunar month does not contain an integral number of days, a tithi may begin and end at any time of the day. This is not a very practical way to keep track of days.

As a matter of fact, the ancients did not really keep track of days by tithi as some writers suggest. They used tithi as markers or tags for solar days which were what they used to keep track of dates. A day in ancient Indonesia and the Philippines started at sunrise and ended with the next sunrise. This compares with our system of midnight to midnight and the Jewish system of sunset to sunset. The tithi in effect at sunrise is the date for the whole solar day.

Because a tithi is shorter than a day by 22.5 minutes, it will occasionally happen that a tithi which begins just after sunrise will end before the next sunrise. Naturally another tithi will begin at that point and will be in effect for the next day. This particular tithi that began just after sunrise will never be used as a solar day marker and will be a "lost" tithi or kṣayatithi. You can readily see that if tithi were really used for dates, there will be no "lost" tithi because they will always occur in sequence from 1 to 15, no matter what.

Casparis explains (1978, 50) that a tithi is lost when a tithi "starting just after sunrise ends before sunset." This is, of course, impossible and he should have written "the next sunrise" in place of "sunset." He also says (1978, 8), "It therefore happens about once in every two months that two tithi begin within the same solar day, with the result that the second tithi is 'lost' or expunged." It is not the second tithi that gets lost (it is in effect the next day), but rather the first one.

The length of the artificial unit tithi was based on one thirtieth of their computed mean lunar cycle of 29.531 days. Corrections were periodically applied as the actual length of a lunar month, being variable, was not an exact multiple (thirty) of a mean tithi. It is probable that a new moon spawns another set of thirty tithi, the correction being applied at this point. This places the full moon in an inconsistent position relative to the tithis at times but may not have been a problem because the exact point of a full moon is difficult to determine from observation.

We do not really know whether they reckoned their day from *observed* sunrise to sunrise or from *mean* sunrise to sunrise. We will assume that they used a mean sunrise of 6:00 A.M. in their computations. This is not only convenient but is not too inaccurate for places near the equator. Passage of time was reckoned by days and the tithi in effect at sunrise was effective for the whole day.

Although there were three-, five-, and six-day weeks as well in Indonesian systems, the system we are concerned with had a seven-day week just as we do. It is the same seven-day week we have and is in step with it. The days of the week (wāra) came from the Greeks, too. They have the same names, as a matter of fact, which were derived from the seven "planets" of the ancients visible to the naked eye: Sun (ravi or sūrya), Moon (candra or soma), Mars (maṇgala), Mercury (budha), Jupiter (brihaspati), Venus (śukra), and Saturn (śani).

The Indonesian versions of the names are the following:

ādityawāra	Sunday
somawāra	Monday
aṇgārawāra	Tuesday
budhawāra	Wednesday
brihaspatiwāra	Thursday
śukrawāra	Friday
śanaiścarawāra	Saturday

This is the last of the components of the specific version of the Indian calendar that we are interested in. The Indian calendar's other features are not present in the LCI and may never have been used in the Philippines.

The LCI year: Shaka 822

The first item on the LCI date is the year *Shaka* 822. All we have to do is add 78 to arrive at the Christian equivalent of 900 A.D. The year therefore started sometime in early 900 and ended in early 901.

The Julian calendar was in effect in 900 A.D., so the year was a leap year and February had twenty-nine days. Under Julian rules, every year divisible by four is a leap year. This is different from our present rules (Gregorian calendar) that state a year is a leap year if it is divisible by four unless it is the end of a century when it has to be divisible by 400.

To determine the start of the year and the months that followed, Robert W. Oliver of Portland, Oregon provided help. He has written a QBasic computer program which he ran to determine the phases of the moon. His program incorporates data and formulas from the book, *Astronomical Algorithms*, by Jean Meeus (Richmond 1991) and has a correction factor of thirty-four minutes for the year 900. Oliver has checked the results of his program against another one written by Ala'a H. Jawad of Kuwait and the results are similar.

The new moons and full moons for February to May 900 in Manila are:

New	February	03	2350
Full		18	1808
New	March	04	0931
Full		19	1149
New	April	02	1829
Full		18	0256
New	May	02	0317
Full		17	1511

The sun entered Pisces at 1921 hours Manila time on 14 February. The vernal equinox occurred at 0141 hours Manila Time on 16 March. The first new moon after 14 February as well as the last new moon prior to the vernal equinox was that of 4 March at 0931. Therefore the new year started on 5 March, the next day when the tithi became effective.

The year starts with the month of caitra *(Chaitra)* which either starts on the day after the first new moon after the sun enters Pisces or the last new moon prior to the vernal equinox depending on whether you believe Casparis or Chakravarty. Luckily, this doesn't matter for *Shaka* 822 for the two new moons are one and the same.

The next month of *Waisakha* (Philippine spelling) started on 3 April because that was the first day the first *tithi (pratipada)* became effective. It was also the start of the first half of the moon or *shuklapaksha*. Again, we are fortunate that the year *Shaka* 822 did not have a double month and we do not have to decide on which month was doubled.

The next half of the moon or *krishnapaksha* started on 18 April because *pratipada* started before sunrise, the official start of day.

The text on the LCI actually reads caturtha *(chaturtha)*, instead of caturthi *(chaturthi)*. We don't know if this was a mistake or the Philippine version of the word.

Since 18 April was *pratipada* (1), *chaturthi* (4) must be 21 April. *Somawara* is the second day of the week or Monday. *Shaka 822, Waisakha, Krishnapaksha, Chaturthi, Somawara* therefore translates as Monday, 21 April 900. A check of the Julian calendar confirms that 21 April 900 was a Monday.

Before I close, let me take care of three more words in Line 1 that I haven't discussed yet. Swasti means "blessings" in Sanskrit (Lanmann 1983, 283) and is used as a salutation much like "Mabuhay" or "Aloha." Warṣātīta means "the year related-to" (Postma 1991, 24). Finally, jyotiṣa is defined as "One of the subsidiary studies (vedānga) of Vedic lore..., a primitive astronomy designed mainly for the purpose of settling the dates and times at which periodical sacrifices were to be performed" (Basham 1954, 489). It is also mentioned by Chakravarty (1975, passim) over and over to refer to a body of knowledge pertaining to astronomical and calendrical science. It should not be confused with jyotis which means "light of dawn or daylight."

Summary

I have used the latest available astronomical data and formulas to arrive at a starting point for Shaka Year 822. From there, I used computations similar to what that people of that era would have employed (like using mean motions instead of true motions) to recreate the calendar. The Shaka calendar is shown on page 524 and the corresponding Julian calendar on page 525.

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The Year 900

January

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		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	28	29	30	31		

February

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					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	28	29	

March

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24/31	25	26	27	28	29

April

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		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	28	29	30			

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				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	28	29	30	31

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
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	28
29	30					

Shaka 822

Chaitra

A	So	Ang	Bu	Bri	Shu	Sha
			1 3/5	2 3/6	3 3/7	4 3/8
5 3/9	6 3/10	7 3/11	8 3/12	9 3/13	11 3/14	12 3/15
13 3/16	14 3/17	15 3/18	1 3/19	2 3/20	3 3/21	4 3/22
5 3/23	6 3/24	7 3/25	8 3/26	9 3/27	10 3/28	11 3/29
12 3/30	13 3/31	14 4/1	15 4/2			

Waisakha

A	So	Ang	Bu	Bri	Shu	Sha
				1 4/3	2 4/4	3 4/5
4 4/6	5 4/7	6 4/8	7 4/9	8 4/10	9 4/11	10 4/12
11 4/13	12 4/14	13 4/15	14 4/16	15 4/17	1 4/18	2 [illegible]
3 4/20	4 4/21	5 4/22	6 4/23	7 4/24	8 4/25	9 4/26
10 4/27	11 4/28	12 4/29	13 4/30	14 [illegible]	15 [illegible]	

The calendar above shows the first two months of the Shaka Year 822 which started on 5 March 900 A.D. The large numbers in the boxes are the dates (numbered by tithi) while the smaller numbers represent the month and the date in the corresponding Julian calendar.

Each lunar month is divided into two halves of fifteen tithi each. The unshaded boxes belong to the bright half of the moon or shuklapaksha. The shaded boxes belong to the dark half or krishnapaksha.

You will notice that the bright half of the moon for the month of Chaitra has a "lost" tithi or keshayatithi. The lost "tithi" is dashami (10) and you will notice that it is skipped in the dating scheme. This computation is based on the best information available at this time as there are no descriptions of how the tithi and sunrises were computed in the old days. The tithi in this calendar are computed as if the lunar cycles were a constant 29.531 days and that the sunrise is at a mean time of 6:00 A.M. everyday. Whatever the lost tithi may finally turn out to be, it would not be far from nawami in the bright half of the moon.

Other important astronomical information

Sun entered Pisces: 14 February 900 at 1921 hours Manila time
First New Moon after Sun entered Pisces: 4 March 900 at 0931
Vernal Equinox: 16 March 900 at 0141
First Full Moon after Sun entered Pisces: 19 March 900 at 1149
Second New Moon after Sun entered Pisces: 2 April 900 at 1829
Second Full Moon after Sun entered Pisces: 18 April 900 at 0256

On 18 February 900 there was a lunar eclipse and the totality was just ending as the moon rose over Manila. In January 900, Venus and Saturn were in conjunction and appeared as one bright object in the skies over Manila. There were also numerous solar and lunar eclipses visible in Manila in the three years prior to the date on the LCI.