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The sexagesimal cycle, from China to Southeast Asia*

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1. Introduction

Since the remotest antiquity, to describe the units of time, the Chinese have used a sexagesimal cycle named *tiāngān dìzhī* 天干地支, or *gānzhī* 干支, formed by combining a decimal cycle, the (ten) Heavenly Stems, *tiāngān* 天干, and a duodecimal cycle, the (twelve) Earthly Branches, *dìzhī* 地支.

This system is attested in the Shang oracular inscriptions (15th-10th c. BCE) to record days. Later, it came to be used to refer to years. In some minority populations, the sexagesimal cycle is used in birth horoscopes to note any unit of time: year, month, day, hour, and even the moment of birth. According to Chinese tradition, the sexagesimal cycle was created in 2637 BCE by Huangdi, *Huángdì* 黄帝, the Yellow Emperor, a civilizing sovereign, when he was sixty. The calendar was calibrated on the birth of Huangdi, and began in 2697 BCE (see Table 1 below).

The name of the first year of the sexagesimal cycle is *jiǎzǐ*, formed by combining the first terms of both cycles. The second year is *yǐchǒu*, the third *bǐngyín*, and so on, spelling out all the possible combinations. The *jiǎzǐ* year appears again every sixty years, starting a new sexagesimal cycle. Seventy-eight cycles have elapsed since the beginning of computation. The year 2013 of the Gregorian calendar (or more precisely, from 2 February 2013 to 31 January 2014), named *guǐsì* 癸巳, is the thirtieth year of the seventy-ninth cycle.

Who was Huangdi? A historical sovereign, or a legendary sovereign? Probably both: a historical leader, transformed and magnified by oral tradition, then re-historicized by the masters of narrative writing. The birth of Huangdi after a gestation of twenty-five months is strangely reminiscent of the birth, after three years of gestation, of Cheuang, a modest civilizer hero of the Khmu, an Austroasiatic ethnic group in Northern Laos. The story of Cheuang appears as an echo of the story of Huangdi. Cheuang was an inventor hero, and more an ecological hero. He created all land traps *except one* so as not to deplete the forest fauna; he created all the water traps *except one* so as not to deplete river life; and so on (Ferlus 1979). In this light, Huangdi can be viewed as a pan-Asian hero.

* This text was kindly translated by Alexis Michaud

Table 1 : The Sexagesimal Cycle from Huangdi to the 23rd SEALS Conference

		decimal cycle	duodecimal cycle	associated animals
2697 BCE: birth of Huangdi	1	<i>jiǎ</i> 甲	<i>zǐ</i> 子	rat
	2	<i>yǐ</i> 乙	<i>chǒu</i> 丑	ox
	3	<i>bǐng</i> 丙	<i>yín</i> 寅	tiger
	4	<i>dīng</i> 丁	<i>mǎo</i> 卯	hare
	5	<i>wù</i> 戊	<i>chén</i> 辰	dragon
	6	<i>jǐ</i> 己	<i>sì</i> 巳	snake
	7	<i>gēng</i> 庚	<i>wǔ</i> 午	horse
	8	<i>xīn</i> 辛	<i>wèi</i> 未	goat
	9	<i>rén</i> 壬	<i>shēn</i> 申	monkey
	10	<i>guǐ</i> 癸	<i>yǒu</i> 酉	rooster
	11	<i>jiǎ</i> 甲	<i>xū</i> 戌	dog
	12	<i>yǐ</i> 乙	<i>hài</i>	pig
	13	<i>bǐng</i> 丙	<i>zǐ</i> 子	rat
2637 BCE: 60 th birthday of Huangdi. Creation of the calendar. Beginning of the 2 nd sexagesimal cycle		<i>jiǎ</i> 甲	<i>zǐ</i> 子	rat
1984: 79 th sexagesimal cycle		<i>jiǎ</i> 甲	<i>zǐ</i> 子	rat
2013: 23 rd SEALS, Chulalongkorn U.		<i>guǐ</i> 癸	<i>sì</i> 巳	snake

We will first consider the duodecimal cycle in a linguistic and cultural perspective: its origin and its association with the twelve animals, and the spread of its use through Southeast Asia in the course of history. Then, we examine two types of decimal cycles in Thai. Finally, we propose an explanation of the origin of the sexagesimal cycle as the combination of two numbering systems: a base-ten system, and a base-twelve system.

Conventions and Abbreviations :

Reconstructions of Chinese : EMC: Early Middle Chinese (Pulleybank 1991). OC: Old Chinese; OC(B): Baxter (1992); OC(B-S): Baxter-Sagart (2011). The reconstructions of Old Chinese put forward by myself, OC(MF), constitute a form of compromise between the previous reconstructions. The superscript, anteposed symbols ^T (tense) and ^L (lax) are syllabic marks, indicating whether the syllable belongs in the tense or lax series (Ferlus 2009). They are equivalent to ^A and ^B notations by Pulleyblank (1994). The exponent ^T corresponds to the pharyngealization -^ʕ- of Baxter-Sagart (2011).

Reconstructions of Viet-Muong (also known as Vietic): PVM: proto-Viet-Muong (Ferlus, partly unpublished reconstruction). VM: Viet-Muong (languages).

Lao tones are indicated by the etymological categories: ^A ^B ^C (syllables ending in voiced sonorant), ^D (syllables checked by voiceless plosive); ¹ (high serie), ² (low serie).

Cycles can be defined by two numerals, combining the rank in the cycle and the number of units for the cycle; e.g. 2-10, the second term of the decimal cycle; and 5-12, the fifth term of the duodecimal cycle.

2. Origin of terms of the Chinese duodecimal cycle

According to the accepted history, it was in Han times that each term of the duodecimal cycle came to be associated with an animal, although the pronunciation of the word in the cycle, and the possible primeval meaning of the phonogram were different from the common name of the animal. For example, *zǐ* 子 (primeval meaning ‘son’) was associated to the animal ‘rat’; *chǒu* 丑 (primeval meaning ‘buffoon’) was associated to the ‘ox’, and so on, up to the last term: *hài* 亥 (no primeval meaning), which was associated to the ‘pig’. What could be the reasons for this association between phonograms (whose usual meaning was no longer known) and animal names? Was the assignment arbitrary? Jerry Norman (1985), in a seminal article, proposed connections with Austroasiatic for six of the twelve terms. We will reconsider these terms in light of the most recent linguistic findings by comparing Chinese and Thai reconstructions of the twelve items, with the common names of animals in Viet-Muong (Vietic) languages, a group of the Austroasiatic family.

2-12. *chǒu* 丑 ‘ox’.

- OC(B-S) *nru*?, OC(MF) ^L*C.ru*? ; EMC *tr^huw*?
- Proto-Thai ***plaw**[?] ; Lao **paw**^{C1}, written *p(l)au*² ປາວ² ; khmu loan **plaw**.
- Common name of the animal: PVM ***c.lu**: ‘buffalo’, Ruc **klu**:¹, Vietnamese *trâu*. Khmer **c^hlu**:, written *chlūv* ផ្លូវ^១ ‘(year of the) buffalo’, is a loan from Old Vietnamese.
- Good correspondence.

5-12. *chén* 辰 ‘dragon’.

- OC(B-S) *dər*; OC(MF) ^L*dzir* ; EMC *džin*.
- Proto-Thai ***si**: ; Lao **si**:^{A1}, written *sī* ສີ.
- Does not match any animal common name.

7-12. *wǔ* 午 ‘horse’.

- OC(B-S) *m.q^ha*? ; OC(MF) ^T*s.ŋa*? ; EMC *ŋo*?
- Proto-Thai ***s.ŋa**:[?] ; Lao **sǎŋa**:^{C2}, written *sṇā*² ສຸ່ນ² ; khmu loan **sǎŋa**:.
 - Common name of the animal: PVM ***m.ŋə**:[?] ; Maleng kari **mǎŋə**:⁴, Vietnamese *ngựa*.
- Good correspondence.

8-12. *wèi* 未 ‘goat’.

- OC (B-S) *mət-s*, OC(MF) ^L*məts* ; EMC *muj^h*.
- Proto-Thai ***mot** ; Lao **mot**^{D2}, written *mōt* ມົດ ; Khmu loan **mot**.
- Common name of the animal: Norman reports Atayal (Formosan) **mirts**.
- Good correspondence but with Austronesian.

10-12. *yǒu* 酉 ‘rooster’.

- OC(B-S) *m.ru*?, OC(MF) ^L*-ru*? ; EMC *juw*?
- Proto-Thai **raw**[?] ; Lao **haw**^{C2}, written *rau*² ຮ້າວ² ; Khmu loan **raw**.

- Common name of the animal: PVM ***r.ka:**; Ruc **rǎka:**¹; Vietnamese *gà*. Norman suggests that Chinese and Thai derived from Viet-Muong form ***rǎk**/***ruk** formed by truncation of PVM ***r.ka:**.

- Unlikely correspondence.

12-12. *hài* 亥 ‘pig’.

- OC(B-S) *gʰəʔ*, OC(MF) *ʰC.giʔ*; EMC *ɣəjʔ*.

- Proto-Thai ***gəʔ**; Lao **kʰaə**^{C2}/**kʰaj**^{C2}, written *gai*² ໄຄ້; Khmu loan **gə:**.

- Common name of the animal: PVM ***ku:r**² (north) / ***gu:r**² (south); Ruc ***ku:l**⁴, Maleng Brô **kù:r**; Viet *cúi*.

- Possible match, but there should be a final sonorant in Old Chinese.

Ultimately, out of the twelve terms of the duodecimal cycle, there are only three (2-12 ‘ox’, ‘buffalo’, 7-12 ‘horse’, and 8-12 ‘goat’), maybe four (if one includes 12-12 ‘pig’), which can be validly compared with the common name of the animal in peripheral languages of the Chinese area, particularly in VM. Nevertheless, this constitutes sufficient evidence to locate the origin of the duodecimal cycle in an Austroasiatic-speaking area, thus confirming Jerry Norman’s innovative idea about the distribution of Austroasiatic languages prior to the expansion of Sinitic and Tai-Kadai (Norman and Mei 1976). The association with animal names, allegedly introduced under the Han, was in fact a way to recall clearly the primeval meaning of the terms of the cycle.

However, this is not the full story: it is not positively sure that all of the terms date back to animal names. One can detect a relationship of derivation between the term of rank ‘two’, 2-12 ^BC.ruʔ, and that of rank ‘four’, 4-12 ^ACm.ruʔ, both based on a single main syllable **-ruʔ**. It has been pointed out that in the history of numbers, ‘four’ was sometimes built as ‘two times two’ (on the history of numbers, see Ifrah 1994/2000). This derivation brings us back to ancient times when people did not need to count because they lived in a culture of unpriced trade. Before the formation of structured numbering systems on a given base, the numbers were put together by processes involving a kind of bricolage (do-it-yourself), which would explain the formation of ‘four’ from ‘two’. The association of ‘four’ to an animal name, ‘hare’ in the present case, would then be a later, arbitrary association.

The terms of the cycle are attested in Shang inscriptions (15th-10th c. BCE), but one can think that they were already in use before that period. This means that Austroasiatic elements came into China at a very ancient date. Where was the territory of the Austroasiatic speakers from whom the Chinese borrowed the duodecimal cycle? At that time, the territory of Shang covered the lower reaches of the Yellow River and the middle reaches of the Blue River, also called Yangzi River (*Yángzǐjiāng* 揚子江). So Chinese culture, which originates in more northern regions, may have been in early contact with an Austroasiatic (southern) culture located on the Blue River, whose Chinese name, *jiāng* 江 ‘river’, is undoubtedly of Austroasiatic origin (Norman & Mei Tsu-lin 1976).

Jiāng 江 ‘river’; OC(B-S) *kʰroŋ*, OC(MF) *ʰkroŋ*. This term is widely represented in the Mon-Khmer languages of Southeast Asia: Bahnaric (Bahnar, Rengao, Mnong) **krɔ:ŋ** (Sidwell 1998); Katuic (Kui, Bru, Sô) **rɔ:ŋ** ‘stream’ (Sidwell 2005); Old Mon *kruñ* **krɔŋ**, Modern Mon *kruñ*, *krūñ* **krɔŋ** (Shorto 2006); Khmu **krɔ:ŋ**; Thai and Lao **kʰɔ:ŋ**^{A1} ‘Mæ Khong’ is a loan from Austroasiatic; South VM (Pong, Cuôi) **kʰrɔ:ŋ**; North VM,

Vietnamese *sông*, Muong **k^ho:ŋ**. Vietnamese *Sông Cửu Long* ‘Mæ khong’ is an outstanding case: *Sông* ‘river’ is the regular form, and *Cửu Long* the transcript of **kro:ŋ** by sinograms.

Also, *jiāng* 江 is involved in a rich family of words built on the root **-roŋ**, whose meanings refer to states and phenomena concerning moving water.

	Karlgren	OC(B-S)	OC(MF)	
<i>jiāng</i> 江	(K.1172v)	k ^ɿ roŋ	^T kroŋ	‘river’
<i>lóng</i> 龍	(K.1193a)	mə-roŋ	^L m.roŋ	‘(crocodile >) dragon’
<i>jiàng</i> 洚	(K.1015d)	-	^T kroŋ-s	‘flood’
<i>jiàng</i> 虹	(K.1172j)	k ^ɿ roŋ-s	^T kroŋ-s	‘rainbow’

These examples, along with the terms of the duodecimal cycle, show clearly the linguistic and cultural significance of the Austroasiatic adstratum in the elaboration of the Chinese language.

When the Ancient Chinese borrowed the terms of the duodecimal cycle, hypothesized to be names of animals, there may have been some changes of animals (Ferlus 2010: 4-5). The term 2-12 ‘buffalo’, an animal of warm and rainy areas, was interpreted as ‘ox’ in northern China, and was then renamed back to ‘buffalo’ in Vietnam and Cambodia. Chinese tradition tells us that the dragon, a mythical animal, was originally a crocodile. Thus, 5-12 ‘dragon’ has replaced ‘crocodile’, a tropical aquatic animal not present in North China, and whose appellation is derived from ‘river’ in Austroasiatic. These two examples reinforce the idea of an Austroasiatic origin of the Chinese duodecimal cycle.

3. Propagation of the sexagesimal cycle to Vietnam

The Vietnamese use the Chinese sexagesimal cycle they name *Can-chi*, combining the decimal cycle *Thập can*, the ‘ten stems’ (see Table 5 below), and the duodecimal cycle *Thập nhị chi*, the ‘twelve branches’ (see Table 2 below). The terms of these two cycles are the Sino-Vietnamese reading of Chinese characters.

However, besides the Sino-Vietnamese reading of sinograms, the twelve associated animals can be named differently than in the common Vietnamese language (Huard et Durand 1954: 77). For want of a better designation, I propose to term this series ‘scholarly Vietnamese’. Of the twelve words, there are seven Sino-Vietnamese names (2-12 buffalo, 3-12 tiger, 5-12 dragon, 6-12 snake, 7-12 horse, 10-12 rooster, and 11-12 dog); one ancient Chinese borrowing into Vietnamese (4-12 hare); and four others whose origin remains unclear. According to various sources, the terms of this series do not form a set of designations for the units of the duodecimal cycle. They are used only when one wants to specify, for example, ‘Such-and-such was born in the year of the Dragon’, in which case the Sino-Vietnamese *long* will be used, not the common *rồng*.

For more detailed information on the calendar and on Vietnamese culture in general, further information is available in Trần Ngọc Thêm (2003).

Table 2: The Chinese duodecimal cycle and its ‘translations’ in Vietnamese

	Chinese			Vietnamese			
	Modern Chinese	Old Ch. (B-S)	Old Ch. (MF)	Sino-Viet.	Scholarly Viet.	Common Viet.	
1	子 <i>zǐ</i>	tsəʔ	^B tsiʔ	<i>tý</i>	<i>thử</i>	<i>chuột</i>	rat
2	丑 <i>chǒu</i>	nruʔ	^B C.ruʔ	<i>sửu</i>	<i>ngưu</i>	<i>trâu</i>	ox, buffalo
3	寅 <i>yín</i>	gər	^B jir	<i>dân</i>	<i>hổ</i>	<i>hổ</i>	tiger
4	卯 <i>mǎo</i>	m ^r ruʔ	^A Cm.ruʔ	<i>mão</i>	<i>thỏ , thố</i>	<i>thỏ</i>	hare, cat
5	辰 <i>chén</i>	dər	^B dzir	<i>thìn</i>	<i>long</i>	<i>rồng</i>	dragon
6	巳 <i>sì</i>	s-gəʔ	^B s.giʔ	<i>tỵ</i>	<i>xà</i>	<i>rắn</i>	snake
7	午 <i>wǔ</i>	m.q ^h aʔ	^A s.ɲaʔ	<i>ngọ</i>	<i>mã</i>	<i>ngựa</i>	horse
8	未 <i>wèi</i>	mət-s	^B mits	<i>mùi</i>	<i>dương</i>	<i>dê</i>	goat
9	申 <i>shēn</i>	lin	^B C.lin	<i>thân</i>	<i>khởi</i>	<i>khỉ</i>	monkey
10	酉 <i>yǒu</i>	m.ruʔ	^B -ruʔ	<i>dậu</i>	<i>kê</i>	<i>gà</i>	rooster
11	戌 <i>xū</i>	s.mit	^B sm.ʔit	<i>tuất</i>	<i>khuyển</i>	<i>chó</i>	dog
12	亥 <i>hài</i>	g ^s əʔ	^A C.giʔ	<i>hợi</i>	<i>trư</i>	<i>lợn</i>	pig

4. The duodecimal cycle with animal names in Cambodia (Table 3 below)

George Cœdès (1935) showed, in a seminal article, that ten of the twelve terms of the cycle were related to the names of the corresponding animals in the Muong dialects of Vietnam. Today, thanks to a better knowledge of the Viet-Muong languages, it is possible to go further in the search for the origin of the terms of the Khmer cycle (Ferlus 2010). Correspondences with all the languages of the Viet-Muong group can now be offered not only for ten words, but for the full set of twelve words, to which must be added the term ‘year’ that always precedes the utterance of the terms of the cycle: *chnām jūt* ‘year of the rat’, *chnām chlū* ‘year of the ox’, etc.

The presence of even one single term from this set of thirteen constitutes strong evidence for assuming the earlier existence of the complete cycle in a given language.

We will compare the twelve terms of the Khmer cycle to the usual designation of the corresponding animals in some languages of the Viet-Muong group, and to their reconstructed form in proto-Viet-Muong (see Table 3 below). The rules of the phonetic history of Khmer (Ferlus 1992) and Vietnamese (Ferlus 1982, 1997) allow to validate the correspondences.

Organization of Table 3 :

Khmer is given in phonetic transcription (*phon.*), transliteration (*translit.*) and in traditional writing (*script*). Old Khmer (Old Kh.), which can be located in the middle of the

first millennium, is on the same level as proto-Khmer, with the difference that the names of the twelve animals and ‘year’ are loans from Ancient Vietnamese.

About Viet-Muong, we give the languages of the northern branch, Vietnamese and a Muong dialect of Hoa Binh (Muong dialects can be considered as dialects of Vietnamese), and those of the southern branch, Pong and Kari (or Maleng Kari), and proto-Viet-Muong.

Table 3: The Vietnamese origin of the twelve animals of the Khmer cycle

	Khmer				Viet-Muong					
	<i>phon.</i>	<i>translit.</i>	<i>script</i>	Old Kh.	Viet.	Muong	Pong	Kari	PVM	
1	cu:t	<i>jūt</i>	ជូត	*juot	<i>chuo̯t</i>	cuot ⁸	-	-	*juot	rat
2	c ^h lou	<i>chlūv</i>	គ្លូវ	*c.lu:	<i>trâu</i>	klu: ¹	klu: ¹	sălu: ²	*c.lu:	buffalo
3	k ^h a:l	<i>khāl</i>	ខាល	*k ^h a:l	<i>khái</i>	k ^h a:l ³	k ^h a:l ³	-	*k.ha:l ²	tiger
4	t ^h ah	<i>thoh</i>	តោះ	*t ^h oh	<i>thỏ</i>	t ^h o: ⁵	t ^h o: ³	-	*t ^h oh	hare
5	ro:ŋ	<i>ron</i>	រោង	*m.ro:ŋ	<i>rồng</i>	ro:ŋ ²	-	ro:ŋ ¹	*m.ro:ŋ	dragon
6	məsəŋ	<i>msāñ'</i>	ម្សាញ	*m.səŋ	<i>rắn</i>	səŋ ³	siŋ ³	-	*m.səŋ ²	snake
7	məm̐i:	<i>mamī</i>	មមី	*m.ŋia	<i>ngựa</i>	ŋia ⁴	-	măŋə: ⁴	*m.ŋə: ²	horse
8	məm̐e:	<i>mamæ</i>	មមៃ	*m.be:	-	-	be: ³	-	*m.be: ²	goat
9	və:k	<i>vak</i>	វក	*və:k	-	və:k ⁸	və:k ⁸	-	*və:k	monkey
10	rəka:	<i>rakā</i>	រកា	*r.ka:	<i>gà</i>	ka: ¹	ka: ¹	ka: ¹	*r.ka:	rooster
11	cə:	<i>ca</i>	ច	*cə:	<i>chó</i>	cə: ³	cə: ³	cə: ³	*ʔ.cə: ²	dog
12	kao/kol	<i>kur</i>	កុរ	*kur	<i>cúi</i>	ku:j ³	ku:l ⁴	ku:l ⁴	*g/ku:r ²	pig
	c ^h nam	<i>chnām</i>	ឆ្នាំ	*c.nam	<i>năm</i>	nam ¹	cim ¹	sănam ¹	*c.nəm	year

Linguistic analysis :

In the Khmer 7-12 *mamī* ‘horse’, the medial **-m-** originate from the progressive assimilation of **-ŋ-** in PVM **m.ŋə:²**. The Khmer inscription K.33 dated 939 Saka (1026 AD) attests *mañya* with the erroneous meaning ‘snake’ (on this issue, see Ferlus 2010: 9-10), which shows that the change **-ŋ- > -m-** was not yet performed. Similarly, in 8-12 *mamæ* ‘goat’, the medial **-m-** result from the regressive assimilation of **-b-** in PVM **m.6e:²**. In addition, the Khmer vocalism **-a-** in 6-12 *msāñ'* ‘snake’ and *chnām* ‘year’ suggests connections to the northern branch (Viet and Muong), rather than to the southern branch (Pong and Maleng Kari) or even PVM. Note that the final glottalization reconstructed in six of the thirteen terms was not transmitted to Khmer.

These considerations confirm that the terms of the Khmer cycle of twelve animals were borrowed from Old Vietnamese. The comparison of Khmer and Vietnamese phonetic histories shows that borrowings are very ancient. Before the Angkorian period there was a transcontinental trade route linking northern Vietnam, at that time a province of China, to

the Gulf of Thailand (Ferlus 2012). The borrowing of the duodecimal cycle with animal names followed this path.

5. The duodecimal cycle in Thai-Yay (Fang Kuei Li's *Tai*)

The Thai-Yay population, that is to say all Thai-Tai and Zhuang (Yay, Dioi, Bu-yi), are using the duodecimal cycle of Chinese origin (see Table 5 below). The Thai (Siamese) and Lao are also using the duodecimal cycle of animals name borrowed from Khmer (see Table 3 above).

Table 4 : The Chinese duodecimal cycle in Thai-Yay

	Modern Chinese	Old Ch. (B-S)	Old Ch. (MF)	proto-Thai	Ahom	Lao	Khmu	Bu-Yi
1	子 <i>zǐ</i>	tsəʔ	^B tsiʔ	*cə:ʔ	<i>teo</i>	caj ^{C1} ໃຈ້	cə:	ɬau ³
2	丑 <i>chǒu</i>	nruʔ	^B C.ruʔ	*plawʔ	<i>plāo</i>	paw ^{C1} ເປື້ຳ	plaw	piu ³
3	寅 <i>yín</i>	gər	^B jir	*ji:	<i>ngi</i>	ni: ^{A2} ຍີ	ni:	nan ²
4	卯 <i>mǎo</i>	m ^r ruʔ	^A Cm.ruʔ	* ^h mawʔ	<i>māo</i>	maw ^{C1} ເໝື້ຳ	^h maw	mau ³
5	辰 <i>chén</i>	dər	^B dzir	*si:	<i>chi</i>	si: ^{A1} ສີ	si:	ɬi ²
6	巳 <i>sì</i>	s-Gəʔ	^B s.giʔ	*sə:ʔ	<i>ceu</i>	saj ^{C1} ໃສ້	sə:	si ³
7	午 <i>wǔ</i>	m.q ^h aʔ	^A s.ŋaʔ	*s.ŋa:ʔ	<i>chi-ngā</i>	sǎŋa: ^{C2} ຊງ້າ	s.ŋa:	sa ⁴
8	未 <i>wèi</i>	mət-s	^B mits	*mot	<i>mut</i>	mot ^{D2} ມົດ	mot	fat ⁸
9	申 <i>shēn</i>	l _o in	^B C.lin	*san	<i>cān</i>	san ^{A1} ສັນ	san	san ¹
10	酉 <i>yǒu</i>	m.ruʔ	^B -ruʔ	*rawʔ	<i>rāo</i>	haw ^{C2} ເຮື້ຳ	raw	zu ⁴
11	戌 <i>xū</i>	s.mit	^B sm.ʔit	*set	<i>mit</i>	set ^{A1} ເສັດ	set	sat ⁷
12	亥 <i>hài</i>	g ^r əʔ	^A C.giʔ	*gə:ʔ	<i>keu</i>	k ^h aj ^{C2} ໃຄ້	gə:	ka ⁴

Linguistic analysis (Table 4 above, and 5 below) :

The Ahom language, extinct since the eighteenth century, is given in the traditional reading memorized by scholars through the phonetics of Assamese. For example, in Table 4, the term 2-12 (proto-Thai ***plaw**^ʔ) is written *paw* (Ahom script) but read *plāo* (Assamese transcription). Khmu has preserved the proto-Thai initials **pl**-, ^h**m** and **r**- (Lao **p**-, **m**- and **h**-). In addition, in Table 5, the final **-h** is preserved in the Khmu **kah**, but not in **taw** because it can not exist in this context. The Khmu borrowings are situated between tonogenesis of the final **-ʔ** and that of **-h** in Lao, probably towards the 8th-9th centuries, the presumed time of arrival of the Thai population in Northern Laos.

6. The decimal cycle in Thai (Fang Kuei Li's *Southwestern Tai*)

Thai-Tai populations (Thai-Tai, Lao, Shan, Lue, Ahom, ...) have the particularity that they use a specific decimal cycle different from the Chinese cycle (Table 5). It does not seem to be attested in Chinese documents.

Table 5 : Comparison of Chinese and Thai decimal cycle

	Chinese decimal cycle				Thai decimal cycle			
	Modern Chinese	Old Ch. (B-S)	Old Ch. (MF)	Sino-Viet.	proto-Thai	Ahom	Lao	Khmu
1	甲 <i>jiǎ</i>	k ^ɿ rap	^T krap	<i>giáp</i>	*ka:p	<i>kāp</i>	ka:p ^{D1} ກາບ	ka:p
2	乙 <i>yǐ</i>	qrət	^L ɾit	<i>át</i>	*rap	<i>dāp</i>	hap ^{D2} ຮັບ	rap
3	丙 <i>bǐng</i>	praŋʔ	^L praŋʔ	<i>bính</i>	*r ^w a:j	<i>rāi</i>	h ^w a:j ^{A2} ຮວາຍ	rǎva:j
4	丁 <i>dīng</i>	t ^ɿ eŋ	^T teŋ	<i>đinh</i>	*məŋ	<i>mung</i>	məŋ ^{A2} ເມືງ	məŋ
5	戊 <i>wù</i>	m(r)uʔ-s	^L m(r)u-s	<i>mậu</i>	*plək	<i>plek</i>	pək ^{D1} ເປືັກ	plək
6	己 <i>jǐ</i>	k(r)əʔ	^L g(r)iʔ	<i>kỷ</i>	*kat	<i>kāt</i>	kat ^{D1} ກັດ	kat
7	庚 <i>gēng</i>	k ^ɿ raŋ	^T kraŋ	<i>canh</i>	*kot	<i>khut</i>	kot ^{D1} ກົດ	kot
8	辛 <i>xīn</i>	sin	^L sin	<i>tân</i>	*ruaŋʔ	<i>rung</i>	huan ^{c2} ຮ້ວງ	ruaŋ
9	壬 <i>rén</i>	nəm	^L nim	<i>nhâm</i>	*taw ^h	<i>tāo</i>	taw ^{B1} ເຕົ້າ	taw
10	癸 <i>guǐ</i>	k ^w ijʔ	^L kiʔ	<i>quý</i>	*ka ^h	<i>kā</i>	ka: ^{B1} ກ່າ	kah

7. The origin of the sexagesimal cycle

The fundamental research issue addressed in this article is the origin of the two cycles: decimal (the ten stems) and duodecimal (the twelve branches).

It has been mentioned above that there are two types of decimal cycles: a Chinese type and a Thai type (see Table 5). There is no telling at present what their origin is, nor whether they were created in these languages or borrowed from others. Neither has it been possible so far to determine the meaning of the elements of these two cycles.

It has also been seen that the duodecimal Chinese cycle is of Austroasiatic origin; to say the least, there are good arguments to propose this hypothesis.

In China, the decimal cycle is combined with the duodecimal cycle from its earliest attestation, composing the sexagesimal cycle. The tradition attributes the invention of the sexagesimal cycle to the Yellow Emperor, Huangdi, and sets its origin at 2697 BCE, the year of his birth. There is no telling when, why and how this combination was created.

Linguistic comparison and reconstruction allow for the identification of animal names for some of the branches of the duodecimal cycle. During the Han period, these terms, which had become opaque to Chinese users, were associated with the (common) names of the intended animals. Later, these twelve zoomorphic names, whose meaning was transparent to Chinese users, were translated into Old Vietnamese, then borrowed holus-

bolus by the Khmer during the pre-Angkorian period. André-Georges Haudricourt considered (although he apparently never wrote this down) that the use of animal names was a mnemonic device. The association of an event with an animal name can make it easier to remember its position in time: for instance, “born in the year of the horse” is easier to remember than “born in the seventh year of the duodecimal cycle”. The astrological connotations which later came to be associated with the animal names reinforced the mnemonic advantages of these animal names.

Combinations between the ten stems and the twelve branches are used to refer to time units: years, months, days, and hours (corresponding to two hours in our counting system). In horoscopes based on the time of birth, it is even possible to name the moment of birth, with a precision of ten minutes. The sexagesimal cycle works as a calendar, but unlike the Gregorian calendar, it is not based on the cycles of sun and moon. The stem-branch pairs are used in the same ways as the names of days (Monday, Tuesday...) and months (January, February...) are used in our calendar. The Western system is based on the lunar cycle: months are based on the moon’s cycles, and a week corresponds to one-fourth of a month. This is unlike the Chinese system, whose origin must be sought elsewhere.

The decimal cycle summons up base-10 numeration. As for the duodecimal cycle, it is tempting to link it up to the twelve lunar cycles in one year, but there is only an incomplete fit in terms of number of days. In the West, some authors have suggested a correspondence between the Chinese duodecimal cycle and the twelve signs of the Zodiac, but again, these are based on lunar cycles.

Taking a fresh look at the problem, since the cycles function as a calendar where each stem-branch pair, *gānzhī* 干支, designates successive units of time, it appears logical to consider the terms as ordinal numbers: a base-10 set, and a base-12 set.

Base-10 numeration is now universally used, whereas base-12 numeration only survives in epigraphic archives, in remote areas of the globe, and in set phrases in various languages. Reliable information about numeration systems can be found in Georges Ifrah (French version: 1994, English version: 2000) and, about Tibeto-Burman, in Mazaudon (2002).

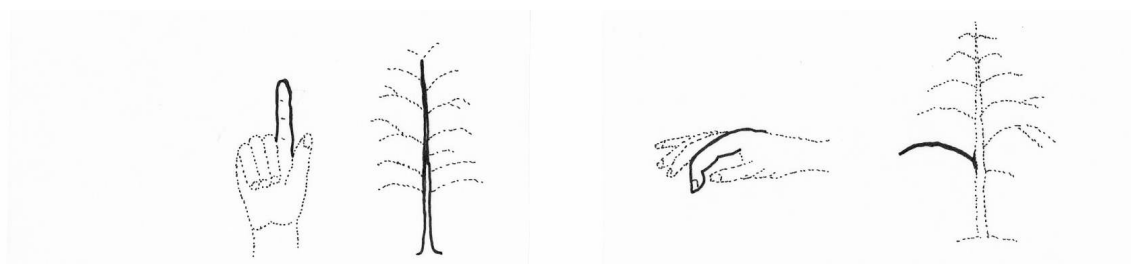
A brief discussion of the nature of numbering systems is in order here. The hand is the first numbering tool; numbers were expressed by gestures before they were put into words. As a result, numbering systems are based on the hand and the fingers. They can be grouped into two main categories:

- Systems using fingers as units: base-5, quinary counting (the fingers of one hand); base-10, decimal counting (the fingers of both hands); base-20, vigesimal counting (all fingers and toes); and base-4, quaternary counting (one hand minus the thumb).

- Systems using portions of fingers (phalanxes): base-12, duodecimal counting. The phalanxes of the four longest fingers are used, yielding a total of twelve phalanxes. In counting, the thumb is placed on the successive phalanxes. This numbering process can be observed here and there the world over; in Laos, it is used when counting years.

Returning to the Chinese stems and branches, the simplest hypothesis consists in considering the two cycles – decimal and duodecimal – as originating in earlier systems for numbering by means of the fingers: these systems would have lost their cardinal function and retained only an ordinal function, in the computation of time units. Let us imagine a hypothetical past when hunters counted with their fingers. When the finger as a whole serves as a unit for counting, it is held erect, facing upwards. When counting up to ten, the

two hands provide a visual image of ‘ten heavenly stems’. When counting by means of phalanxes, the finger is curved, bent, oriented towards the earth rather than towards the sky, to bring out individual phalanxes, hence the appearance of the ‘twelve earthly branches’.



Heavenly Stems (天干)

Earthly Branches (地支)

Viewed in this light, the phrase ‘*ten heavenly stems - twelve earthly branches*’ is like a code encapsulating the prehistorical origin of these two numbering systems.

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