



# SYSTEMS OF CARDINAL NUMERALS IN LANGUAGES AROUND THE WORLD

Pavel Petrov

Kaliningrad, Russia

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**Abstract.** This paper is an in-depth discussion of the diversity of counting systems developed by different peoples, which manifests itself both in lexical differences/similarities of the terms used for numerals, and in diverse operational schemes for the abstract numbering of things. The goal of the study was to bind together and clarify the variety of the counting systems that were found. During communication, speakers of languages with different counting systems face the difficulty of translating words which describe quantity, i.e. numerals. The widely used decimal system is also not devoid of surprising features. The present study focused on analysing various complex systems of counting in terms of both vocabulary and conceptual methods used by different peoples. The research data collected from academic literature provide numerous examples. The comparative method is used to show how extraordinarily inventable different civilizations were in approaching the problem of defining quantity. Particular attention is paid to the phenomenon of using specific things, such as hands, fingers, and animal names, to create counting systems. A case study of the numerals of some Austronesian languages demonstrates that a whole associative row can be traced, revealing that long ago respective peoples solidified the abstract concept of quantity into simple and clear definitions based on real things. The main result of the study is a comparison of more than 20 counting systems. The abundance of examples substantiates the idea of how many unexpectedly different and original numbering methods were used by the ancestors of different peoples and how many of them are still supported by their descendants and even unwittingly ensconced in the modern technological civilization. This paper is also supplemented by a review of the systems of birth-order names for children in several languages of the Indo-Pacific region and America.

**Keywords:** cardinal numerals, counting system, digit, Austronesian languages, birth-order names

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# СИСТЕМЫ КОЛИЧЕСТВЕННЫХ ЧИСЛИТЕЛЬНЫХ В ЯЗЫКАХ МИРА

П. В. Петров

Калининград, Россия

**Аннотация.** Целью настоящей статьи является углубленное раскрытие многообразия систем счисления разных народов, которое проявляется как в лексических различиях или сходстве терминов, используемых для числительных, так и во множестве операционных схем для абстрактной нумерации. В процессе коммуникации носители языков с разными системами счёта сталкиваются с трудностью перевода лексики, выражающей количество, то есть числительных. Привычная десятичная система также не лишена неожиданных особенностей. В работе анализируются различные сложные системы счёта с точки зрения как лексики, так и концептуальных методов, используемых разными народами. Материалом для исследования служат многочисленные примеры, собранные из научной литературы. В работе используется компаративный метод, чтобы показать, как чрезвычайно изобретательны были представители разных цивилизаций в определении количества. Особое внимание уделено феномену использования конкретных понятий, таких как руки, пальцы и животные, для создания абстрактных систем счёта. На примере числительных некоторых языков австронезийской семьи прослеживается целый ассоциативный ряд, показывающий, как в древности соответствующие народы дали понятию количества простые и наглядные определения. Основным результатом исследования является сравнение более чем 20 различных систем счисления. Обилие примеров обосновывает мысль о том, как неожиданно многообразны и оригинальны были методы счёта, использовавшиеся предками разных народов. Многие из них до сих пор сохраняются их потомками и даже невольно проникли в современную технологическую цивилизацию. Настоящая статья также дополняется обзором систем присвоения имён детям по порядку их рождения в нескольких языках народов Индо-Тихоокеанского региона и Америки.

**Ключевые слова:** количественные числительные, системы счёта, цифра, австронезийские языки, имена по порядку рождения

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## Introduction

The languages of the world are divided by linguists into stocks, families, subfamilies (or branches), and groups to unify them according to more or less regular lexical features or convergences. These lexical similarities can be explained by geographical location, language contacts, or historical background data. In addition to the lexical designations for real objects, each language has operational schemes for the treatment of abstract matters, well exemplified by numeral names. What is strange is that sometimes languages embraced within the same grouping show evidence of different approaches to numeration that are independent of geographical location. This finding means that the logic in the creation of various numerical series had taken different paths. In some cases one might explain such differences as attributable to different levels that some civilizations had attained. For example, recent epigraphic discoveries in Central America appear to indicate that either the very early Maya or the non-Mayan indigenous peoples preceding the Maya were already using a well-developed numbering system, one that the ancient Maya used as their civilization further developed. We, too, readily assume that the highly organized Maya knew the concept of zero, but what they actually had was a “completion” symbol at the end of each numerical series (for example, 1 to 19 and then “completion”, *mi* (*mix?*) (Yucatecan *mix* [miš]) “zero, completion” [39], implying but not meaning ‘20’, except in that series), and they could manipulate cosmic-scale numbers (numbers of immense size). In contrast, the Khoisan-speaking peoples in South Africa still do not say numbers above four though they may have conceptual and mental control over the higher unnamed numbers. The author of these words is not aware of any primitive numbering by the ancient Maya before their civilization developed, for the numeration appeared fully formed. This paper describes the different counting systems that existed and still continue to exist over the wide spaces of the Earth.

## Nominal bases used in numeration

Linguists pay special attention to the part of speech called “numerals”, as, for example, in using them for the names of language groups to separate one major Indo-European group, *satem*, from the other group, *centum*, after the distinctive numeral ‘100’. Celtic languages are divided into P-Celtic and Q-Celtic. The difference between P-Celtic and Q-Celtic depends on common sound changes: ‘4’ in Welsh is *pedwar* (initial *p*), but in Irish *ceathair* ([kya-har] initial “c” [k], originally “q” [kw])<sup>1</sup>. Another example is the obsolete division of Mande languages into Mande-Fu and Mande-Tan groups after the number ‘10’ in these languages of West Africa. Yet another example is the name of the Penutian linguistic family of North American Indians, which is expressed by the cardinal numeral ‘2’ *pen* and *uti* respectively [66]. Roland Dixon and Alfred Kroeber also used the numeral ‘2’ for the North American Indian group “Hokan” in 1913 [16] (cf. Atsugewi ‘2’ *hoqi* and Shasta ‘2’ *xuk’wa*).

Two more Amerindian language groups were named after the number ‘2’ in their languages. “Iskoman” is based on the Chumashan word (*iškómo*), and “Ritwan” on the Wiyot word (*dit-*; *d* represents a one-tap *r*). The Mosan division is based on the words *mōs* or *bōs*, corresponding to the number ‘4’ in the Salish, Wakashan, and Chimakuan languages.

However, some tribes of Australia and South America manage **without numeration**. For example, Yamana (Strait of Magellan) uses the words “sole”, “a pair”, “trio”, “a few”, “several”, “many”, “a good number”, “enough plenty”, and “a great number” to express some quantity. This language has as many as four numbers for those purposes – singular, dual, trial, and plural [31].

The following classes of numeration are manifest throughout the world.

<sup>1</sup> Parsley, I.J. USRC Home, 2000, [geocities.com/Athens/Rhodes/1677/ullans.html](http://geocities.com/Athens/Rhodes/1677/ullans.html) (accessed 22 October 2001).

**Binary numeration** (based on two) occurs in Australia, New Guinea, South America, and Africa. Such counting terminates in '4', after which follow the words "few", "several", and "many". However, sometimes repeated counting is continued to five or ten or as in the numerals of the Western Torres Strait Islands described by Alfred Haddon in 1889 [28]:

1 <i>urapun</i>	4 <i>okosa-okosa</i>
2 <i>okosa</i>	5 <i>okosa-okosa-urapun</i>
3 <i>okosa-urapun</i>	6 <i>okosa-okosa-okosa</i>

Everything greater than six they called *ras*.

**Ternary numeration** (based on three) may be noted in Ona (Tierra del Fuego) [37]:

1 <i>sos</i>	4 <i>kóne shóke</i> ('twice two')
2 <i>shóke</i>	5 <i>sos chen win</i> ('one hand like')
3 <i>sháuken</i>	6 <i>kóne sháuken</i> ('twice three')

The people who speak Mojeño, or Trinitario, an Arawakan language of Bolivia in South America, do not appear to be able to count beyond three; arriving at that, they commence again and have to arrange all their calculations in sets of threes [41]:

1 <i>etona</i>
2 <i>apina</i>
3 <i>mopona</i>

Thus, for a peso, or dollar, which contains eight reales, they count *apina mopona* and *apina*, or 'two threes and two'.

**Quaternary numeration** (based on four) is present in several languages of New Guinea and North America. This system is established when the hand is considered without the thumb. So number '10' in the Papuan language Kewa is:

*ki lapona kode lapo* ('two hands and two thumbs') [36]

For example, in the "old style" of the Ventureño dialect, as given by Father José Francisco de Paula Señan (ca. 1800), there is the following [55]:

1 <i>paqueet</i>	5 <i>itipaqués</i> ('iti-1')
2 <i>eshcóm</i>	6 <i>yetishcóm</i> ('yet-2')
3 <i>maség</i>	7 <i>itimaség</i> ('iti-3')
4 <i>scumú</i>	12 <i>maség scumú</i> ('3-4')

**Quinary numeration** (based on five) is an extremely common type of system. Apparently, all the examples are connected with the quantity of the fingers on the hand. They are found in Gur, Kru, West Atlantic, Cariban, Arawakan, Otomí, Nahuatl, and so on. For example, the Khmer numerals are as follows [40]:

1 <i>muoy</i>	6 <i>pram muoy</i>
2 <i>pir</i>	7 <i>pram pir</i>
3 <i>bei</i>	8 <i>pram bei</i>
4 <i>buon</i>	9 <i>pram buon</i>
5 <i>pram</i>	10 <i>drap</i>

**Senary numeration** (based on six) is used by the Papuan Ekagi and the Costanoan Indians of California Penutian. Here is a trace of the system based on six in Santa Clara Costanoan [13]:

1 <i>im-hen</i>	7 <i>kenetc</i> (cf. Miwok '1' <i>kene</i> )
2 <i>utin</i>	8 <i>osatis</i> (cf. Miwok '2' <i>osa</i> )
3 <i>kapan</i>	9 <i>telektic</i> (cf. Miwok '3' <i>teleka</i> )
4 <i>katuac</i>	
5 <i>mucur</i>	
6 <i>caken</i>	

**Septenary numeration** (based on seven) is very rare. As far as the author knows, it is represented in the North Arawakan (Eastern Maipuran) language Palikúr only. The Palikúr numerical system is basically decimal, but the most unusual feature is that the numerals '8' and '9' are based on the term for numeral '7' [24].

7 <i>n-teunenker</i>	
8 <i>n-teunenker a-kak paha-t ar-auna</i>	'7 and one more added'
9 <i>n-teunenker a-kak pi-ta-na ar-auna</i>	'7 + 2'
19 <i>madikauku a-kak n-teunenker ar-auna a-kak pi-ta-na ar-auna akiu</i>	'10 + 7 + 2'
90 <i>n-teunenker madikwa a-kak p-i-na madikwa ar-auna</i>	'7 tens + 20'
199 <i>madikauku madikwa a-kak n-teunenker madikwa a-kak p-i-na</i>	'10 tens + 7 tens +
<i>madikwa ar-auna a-kak n-teunenker a-kak pi-ta-na ar-auna akiu</i>	2 tens + 7 + 2'

**Octonary numeration** (based on eight), apparently, is based on both of the hands without the thumbs. It was typical in Proto-Dravidian [2]. Also, this system is inherent in Round Valley Yuki [15]:

1 <i>pa"-wi</i>	9 <i>hutcam-pa"-wi-pan</i> ('beyond-1-hand')
2 <i>op-i</i>	10 <i>hutcam-opi-sul</i> ('beyond-2-body')
3 <i>molm-i</i>	11 <i>molmi-sul</i> ('3-body')
4 <i>o-maha"t</i> ('2-forks')	12 <i>omaha"t-sul</i> ('2-forks-body')
5 <i>hui-ko</i> ('middle-in')	13 <i>huiko-sul</i> ('middle-in-body')
6 <i>mikas-tcil-ki</i>	14 <i>mikastcilki-sul</i> ('6-body')
7 <i>mikas-ko</i>	15 <i>mikasko-sul</i> ('7-body')
8 <i>paum-pat; mipat-al-a-wa</i>	16 <i>hui-co(t)</i> , and words used for '8'

Quite possibly, **nonary numeration** (based on nine) had once been present in Old Russian, but actually it was used in trading only. Apparently, it was convenient to count by nines and nineties as well as by dozens. Old Russian had the word '90' in the form of a noun [57]:

*dva devyanósta* ('two-90 [units]')  
*s tremyá devyanósty* ('with three-90 [units]').

Modern Russian has only *tridev'átroye tsárstvo* ('thrice-nine kingdom'), a term in Russian popular tales and a special construction of '90' in contrast to that in other Slavic languages and reminiscent of that. Russian '80' is *vósem'desyát* ('8×10'); '90' is *devyanósto* ('9-[n/n<d+o/a?]-100'). Other Slavic languages have '90' as '9×10'. See also Appendix A.

We can read the next specimens with numerals in the Bābar-Nāma text from the 15<sup>th</sup> century [6]:

*bir toquz at wā bir toquz parčā* ('1×9 horses and 1×9 pieces [of fabric]')  
*üč toquz ton* ('3×9 clothes')

Many Turkic languages still have some traces of this usage.

Also, in regard to trade relations, there were merchants of Old Russia who spoke Ofenian, a special trade language that Peter Pallas called “*Súzdal’skiy*” after the Suzdal Principality, a well-known commercial state [44]:

1 <i>yûnoi</i>	6 <i>shyûnda</i>
2 <i>zd’iû</i>	7 <i>sizim</i>
3 <i>strem</i>	8 <i>vondora</i>
4 <i>tisera</i>	9 <i>dívara</i>
5 <i>pyonda</i>	10 <i>dekan</i>

This language was built on roots from broken Greek, Russian, Persian, and so forth.

William Woodhill Rockhill during his journey through Mongolia and Tibet noted that Chinese traders make use of certain terms known only to themselves to express numerals. These terms, called *yen-tzŭ* in western China and *t’iao ka-erh* in Beijing, vary in each locality and even in each branch of trade, such as horse traders, inn keepers, and flour dealers. Here is a sample from Hsi-ning Fu and Ta-chien-lu (in Sichuan) [50]:

1 <i>Ch’ien tzŭ-erh</i>	6 <i>Nao tzŭ-erh</i>	11 <i>Ch’ien tzŭ ch’ien</i>
2 <i>Ch’ou tzŭ-erh</i>	7 <i>Tiao tzŭ-erh</i>	12 <i>Ch’ien ch’ou</i>
3 <i>Tsang tzŭ-erh</i>	8 <i>K’ou tzŭ-erh</i>	15 <i>Ch’ien pao</i>
4 <i>Su tzŭ-erh</i>	9 <i>Sao tzŭ-erh</i>	20 <i>Ch’ou ch’ien</i>
5 <i>Nien tzŭ-erh</i>	10 <i>Ch’ien tzŭ-erh</i>	25 <i>Ch’ou pao</i>
		55 <i>Nien tzŭ nien</i> , etc.

As is generally known, there are other trade languages in the world such as the Bangala trade language and the Oregon trade language, later known as “Chinook Jargon”. The latter was researched by Horatio Hale in 1890 [25].

**Denary, or decimal numeration** (based on 10) is widely practiced, but even here there are some nuances too. To use the decimal system of Hindi, for example, it is necessary to know all numeral names from one to 100 because they are quite independent of the tens and the single digits [40].

The Naukan Inuit (St. Lawrence Island Yupik) call ‘9’ *qulhugutñilñuq* (that is, ‘not 10 is’) to contrast it with the importance of ‘10’ (though they have the vigesimal system) [42], whereas the Cree Indians similarly but in contrast call ‘9’ *kéka-mitātat* (‘almost 10’) [61]. Here is an example of a decimal system as used by the African Yorùbá for big numbers [3]:

‘525’ is *òrìn dín légbèta ólé márùń* (‘[200×3] - [20×4] + 5’).

Cf. English ‘525’, which is (‘5×100) + 20 + 5’.

**Undenary numeration** (based on 11). In the 19th century, a statement appeared that immediately attracted attention and awakened curiosity. It was to the effect that the Maoris, of New Zealand, used the number 11 as the basis of their numeral system. To that number they counted by means of simple words; ‘12’, ‘13’, ‘14’, etc. were with them ‘11-1’, ‘11-2’, ‘11-3’, etc.; the multiples of ‘11’, that is, ‘22’ and ‘33’, etc. were formed directly on the word for ‘11’; and the square and cube of ‘11’, or ‘121’ and ‘1,331’, were expressed by simple words having no connection with the names of smaller numbers [12].

However, more accurate knowledge of the Maori language and customs served to correct the mistake by showing that this system was a simple decimal one, and that the error arose from the following habit. Sometimes, when counting a number of objects, the Maoris would put aside 1 to represent each 10, and then those so set aside would afterward be counted to ascertain the number of tens in the heap. Early observers among this people, seeing them count 10 and then set aside 1 at the same time pronouncing



the word *tekau*, imagined that this word meant 11 and that the native was making use of this number as his base. This misconception found its way into the early New Zealand dictionary, but it was corrected in later editions [13].

**Duodenary numeration** (based on 12) originated in Old Sumerian. It is assumed that such a system arose based on the number of phalanges of the four fingers (excluding the thumb) when counting them with the thumb of the same hand. Today, such a mode of numeration can be found in the language of Aten (of northern Nigeria) [7]:

13 = 12+1	144 = 12×12
21 = 12+9	145 = 144+1
30 = 12×2+6	156 = 144+12
40 = 12×3+4	1,961 = 1,000+(144×6)+(12×8)+1
100 = 12×8+4	

**Tredenary numeration** (based on 13) was used in the Maya Calendar because they had a week of 13 days. Evenks made a calculation by using six joints of both hands and a head.

**Quindenary numeration** (based on 15) is present in two languages of Guinea (Guinée). Banyun and Dyola both express '15' by the noun meaning "leg". In Banyun the plural "legs" means not '20', as might appear, but a multiple of 15, thus [70]:

15 *cidix*  
30 *cidix-əŋ a-nak-əŋ* ('15×2', lit. 'legs two').

The numbers '45' and '60' are recognized as multiples of 15, but this is not the accepted usage now, since the decimal system is preferred above 30.

Although modern Welsh uses base-10 numbers, the traditional system was base-20, with the added twist of using 15 as a reference point. Once you advance by 15 (*pymtheg*), you add units to that number. So 16 is *un ar bymtheg* ('1 on 15'); 36 is *un ar bymtheg ar hugain* ('1 on 15 on 20'); and so on.

**Sedenary numeration** (based on 16) was present in Bai ('white [people]', formerly called Minjia), an uncertain Northeastern Tibeto-Burman isolate but a heavily Sinicized language of Yunnan in southern China as early as the 12<sup>th</sup> century (Nánzhào kingdom). Modern Bai employs the decimal system. However, a study of the currency of shellfish used during the 12<sup>th</sup> to 14<sup>th</sup> centuries, performed by Xu Lin and Fu Jingqi, reveals different units. The big shellfish are represented by fingers. A *ba* ('shell') is called *zhuang*; four *zhuang* make a *shou* ('a hand'); four *shou* make a *mi* or *miao* ('a man'); and five *miao* make a *suo* (1 *suo* = 80, or 16×5). In effect, the Bai consider 'hand' as four (excluding the thumb), and four hands (or 4 hands-and-feet) properly make a man with 16 'digits', or 'fingers' [21].

**Vigenary, or vigesimal systems** (based on 20) are met in Breton, Basque, Georgian, and so forth. Here are a couple examples:

Kryz (Lezghian) '100' is *fi-q'ad* ('5×20') [1].

Bats '1,453' is 3×(20×20)+(12×20)+13 [53].

Ch'ol (Mayan) '1055' is *ča'bahk' yik'ot ho'luhumpehl i ušluhunk'al* (that is, 'two-400-units with 15 [beyond 240] toward thirteen-20-units') [5].

**Quadrivigenary system** (based on 24) is reported in the Kaugel language of Papua New Guinea [8]. *Tokapu* means '24'; *tokapu talu* means '24×2' = '48'; and *tokapu tokapu* means '24×24' = '576'.

**Quinviginary system** (based on 25) is described in the Gumatj (Anindilyakwa) language of Australia. In this way they calculate at least up to 625<sup>2</sup>.

**Tricenary system** (based on 30) seems to be known as a rare one. Mbula-Bwazaa from Nigeria use it as follows<sup>3</sup>:

1 <i>mon</i>	30 <i>a mon</i> = '1×30'
2 <i>rap</i>	60 <i>a rap</i> = '2×30'
3 <i>taru</i>	90 <i>a taru</i> = '3×30'

**Duotricenary system** (based on 32) is found in the Ngiti language of Zaire<sup>4</sup>:

2 <i>ɔyɔ</i>	64 <i>ɔyɔ wădhi</i>
3 <i>ibhu</i>	96 <i>ibhu wădhi</i>
4 <i>ifɔ</i>	128 <i>ifɔ wădhi</i>
32 <i>wădhi</i>	

**Quadrigenary numeration** (based on 40), according to Jaroslaw Kesler, is the beginning of trade, that is, the use of all fingers of the seller and the buyer<sup>5</sup>.

One can find the expression *sorok sorokov* (that is, 'forty forties', or '1,600') in Old Russian.

This system can be found in Old Hawaiian. Edward Doane noted in his paper "A comparison of the languages of Ponape and Hawaii" of 1894: "Formerly, in counting, the Hawaiians, when they reached the number *forty*, turned back and commenced at one and counted another forty, and so on till they laid aside ten forties; these 'ten forties' they called a *lau*, four hundred" [17, p. 438–439].

The Sandwich Islanders reckon by forties: they call forty, *teneha*; ten *teneha* is a *lau*; ten *lau*, a *manu*; ten *manu*, a *kini*; ten *kini*, a *lehu*; ten *lehu*, a *nurwane*; ten *nurwane*, one *pao* [9].

According to Robert Oswalt, Kashaya (Pomoan) speakers could count to very long numbers (thousand and millions) using units of 40 (-hay 'stick').

**Sexagenary numeration** (based on 60) was established in Old Sumerian about 3000 B.C. [33]:

240 <i>giš-lim</i>	('60×4')
300 <i>giš-i</i>	('60×5')
360 <i>giš-àš</i>	('60×6')

We can see that we have inherited this method when we divide one hour into 60 minutes and one minute into 60 seconds.

The Kapauku of Papua New Guinea use a decimal counting system that stops at 60 and starts over again, having as higher units 600 and 3,600 [47].

Another interesting finding is that Achomawi (Shastan) '70' and '80' are not decimal but are formed from '60' as the base [13]:

<sup>2</sup> Hammarström, H. Rarities in numeral systems, 8 September 2006, academia.edu/3142314/Rarities\_in\_numeral\_systems (accessed 29 August 2023).

<sup>3</sup> Seiler, W. & H. Mbula-Bwazaa, Adamawa, Nigeria, 28 April 2008, lingweb.eva.mpg.de/channumerals/Mbula-Bwazaa.htm (accessed 29 August 2023).

<sup>4</sup> Hammarström, op. cit.

<sup>5</sup> Kesler, Y. Schislenie i kalendar' [Counting and calendar], history.wikireading.ru/304010 (accessed 22 February 2022).



- 60 *masutj-il malusi*  
 70 *masuts-wade hamisatumi malusi*  
 80 *masuts-haq-ilatumi malusi*

There is unexpected numeration in the Tombo-so dialect of Dogon (Mali). They use **denary numeration** (based on 10) from one to 80, **octogenary numeration** (based on 80) from *kesū* '80' to 800, and then **octocentenary numeration** (based on 800), as follows [65]:

- 100 *kesūle pɛ:ne* ('80+20')  
 320 *sūnai* ('80×4')  
 2000 *munjone: sū:nɔ* ('[800×2]+[80×5]').

It is normal for some languages to use **combined types of numeration** such as 2-10, 2-20, 4-10, 4-20, 5-10, 5-20, and a more difficult one such as 2-4-5-6-20 (Coahuiltecan) [11]:

- |                     |                 |
|---------------------|-----------------|
| 1 <i>pil</i>        | 9 4+5           |
| 2 <i>ajtê</i>       | 10 5×2          |
| 3 2+1               | 11 5×2+1        |
| 4 <i>puguantzan</i> | 12 4×(2+1)      |
| 5 <i>juyopamáuj</i> | 16 5×(2+1)+1    |
| 6 <i>chicuas</i>    | 19 6×(2+1)+1    |
| 7 4+(2+1)           | 50 (20×2)+(5×2) |
| 8 4×2               |                 |

Many languages of the world have numeral names connected with fingers and toes both directly and indirectly. In some Siberian languages the word 'to compute' is literally 'to finger'. The Chukchee 'fingers' *rylgy-t* became 'compute' *rylgy-k* [67]. The Tule Indians of Darien reckon in this way: '20' is 'a man', that is, 'all fingers and toes'; '100' is '5 men'; and so on [61]. Apache '2' is *naki* (from *ki-e* 'foot [feet]') [ibid.], but Carl Masthay regards this apparent similarity as having no basis in Athabaskan<sup>6</sup>.

Using the fingers for counting is achieved by different modes, such as the sequence of finger to finger or the thumb of one hand to the thumb of the other, as in the Zulu (Bantu) method, or thumb to little finger, as in the Vei (Mande) method [ibid.].

Tumet (an Inner Mongolian dialect) '7' is *doloo(n)*, but the index finger is *doloovor* [59].

Generally, the word "hand" is found to serve as a numeral quite often:

Creek (Muskogean) '1' is *hūmke* (from *heyūn enke* 'this hand') [61].

Kewa (Papuan) '4' is *ki* ('hand') [36].

Nama (Hottentot) '2' is *t'koam* ('hand', by analogy with their quantity) [61].

Chamorro (Micronesia) '5' is *lima* ('hand') [60].

Inuit (Eskimo) '5' is *tal'imat* ('hand') [26].

The Wingei dialect of Ambulas number '6' *taabak* shows the hand as having six features, whereas '12' is *taaba v'etik* ('two hands') [69].

All the following in Sanskrit mean '2': *kara* 'hand', *bāhu* 'arm', *netra* 'eye' [61].

Gaahmg (Nilo-Saharan) use the word 'eye' as well but in a different way: '7' *idīg-dāāgg* 'eyes-two' is based on the two eyes, apparently in addition to the five fingers of one hand, which are not included in the numeral [56].

<sup>6</sup> Carl Masthay to Pavel Petrov, personal communication of 24 November 1998.

In nearly all non-Austronesian languages of the Alor and Pantar Islands (East Indonesia) '5' is possibly expressed by a root meaning 'tooth'. Compare the following pairs of these words: Lamma (Biangwala) – *y'asiŋ* / *naw'asiŋ*; Tewa (Sargang) – *y'awan* / *naw'an*; Blagar (Retta on Ternate) – *aw'əhaŋ* / *naŋ'əhaŋ* (the straight apostrophe here indicates relative prominence of its following vowel) [58].

Takelma (southwestern Oregon) '10' is *ixdil* ('hands [both]') [51].

Very unexpected is that Yuki (California) '8' is *pompāt* = *powe* + *mepat* ('one hand'). The point is that Yuki Indians count using sticks; for example, '8' is expressed by two sticks set between each two fingers. Several variant forms have been obtained for '8' such as 1-flat; hand-stick-flat; hand-2-cut; hand-on-cut; hand-2-only; and so on. What is more, the name for '8' is also used for '16' and '24'; '9' is used for '17' and '25'; '10' is used for '18' and '26'; and so forth [15].

Finally, Alor-Pantar languages (East Indonesia) give curious numerals. Lamma of the Pantar Island use 'hand' to express number '9': in the Biangwala dialect '1' is *han'uku*, and '9' is *hanukt'anəŋ* 'one-hand'. Kafoa of the Alor Island use 'foot' for the same number: '1' is *n'uku*, and '9' is *tik'əynuku* 'foot-one' [58].

One more example: Tunisian Arabic *xāms-a* ('5') bears no relation to "hand" as it is but is a taboo word for women. So, they are obliged to call '5' allegorically by the word *əṭṭyəddək* ('count your hand') [71].

The subject of Arabic numeration will not be fully discussed if one does not mention their word for '10', *āshara*. Modern Egyptian Arabs call a left-handed person *qā šaru*. It means that earlier they had different terms for the left and right hands [38]. Today, they call the left hand simply *yad shemal*. The lost protoform for the left hand served as the origin for both "left-hander" and the numeral '10'. The point is that long ago Arabic calculation on fingers commenced from the right hand and then switched to the left one. When they reached the tenth finger, their left hand had been completed.

In Old Russian, they calculated similarly but in the opposite way: from the left hand, called *shuytsa*, to the right one, *desnitsa*, hence *desyat* '10'.

The common Turkic word *on* '10' can be compared with *on* 'right' as well.

Similarly, there are languages in the world that have some differences in the speech of men and women, such as Dagestanian Andi, where '8' is *bijq'igu* and *bejq'igu* respectively [63].

Of further interest are the **body-counting systems** of New Guinea Papuan, as in Hewa [46]:

1 <i>name</i> ('left thumb')	6 <i>maluene</i> ('left wrist')
2 <i>namalu</i> ('left index finger')	7 <i>tagu</i> ('left arm')
3 <i>favalo</i> ('left middle finger')	8 <i>aluene</i> ('left elbow')
4 <i>kolu</i> ('left ring finger')	... ..
5 <i>keli</i> ('left little finger')	27 <i>kay-keli</i> ('right little finger')

As one can easily see from such systems, counting is limited. So the Duna and Huli are able to count to 14 only; Pole, to 15; Yuri, Enga, and Karam, to 23; Yonggom, to 25; Telefol, Sibil, Orokelo, and Hewa, to 27; Gende and Ninggerum, to 31; Yupno, to 33; Kutubu, to 37; and Kewa to 47 [36]. The range of bases in New Guinea runs from 14 to 74.

Sometimes, curious patterns occur, as in nonhuman body numerals:

Sanskrit *paksha* 'wing' is used also for '2' [61].

The Xerênte (Ge-Pano-Carib) '2' *ponhuane* means 'deer track', since a deer hoof print has two separate spots<sup>7</sup>, and their word for '3' means 'rhea bird footprint' (the rhea bird has three distinctive toes, but see the next sample) [18].

The Abipones of Paraguay count '4' as *geyèknute* ('the ostrich's toes') [61]. The ostriches of South America (the rheas) possess four claws on each foot, three in front and one at the back (Fig. 1).

<sup>7</sup> Rosenfelder, M. Numbers from 1 to 10 in over 5,000 languages, 2015, [zompist.com/numbers.shtml](http://zompist.com/numbers.shtml) (accessed 31 October 2015).

It is curious that in Manga, a Kanuri language in Africa, '4' is *déwú*, but similarly they call 'ostrich' *déwú* [32]. In contrast to the South American ostrich, an African ostrich has only two toes on each foot, hence four toes in total for both feet (Fig. 1).

The Australian ostrich is not left out of the numeration either. The numeral '3' \**kulparri*, in the Karnic subgroup of Pama-Nyungan, has been reconstructed to 'emu', motivated by the bird's three large, splayed toes [18] (Fig. 1).

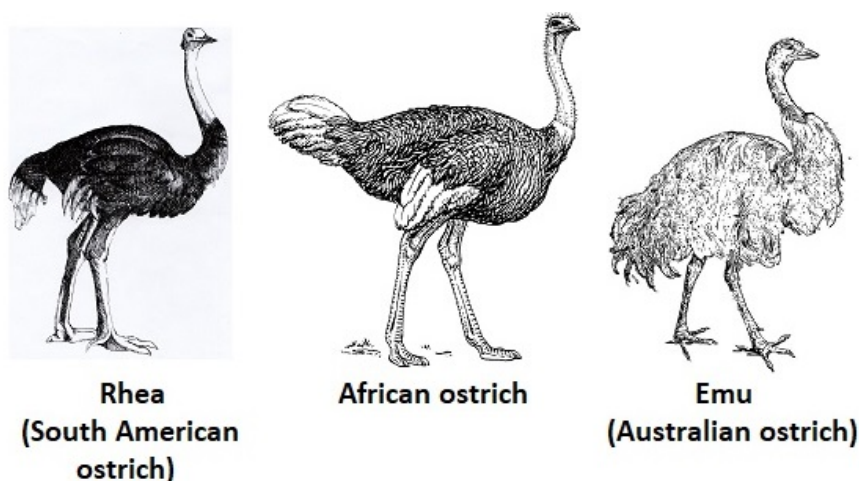


Figure 1. Ostriches<sup>8</sup>

The Boiken of New Guinea count '4' as *nawara* (such as *napa wara* '1 dog') [19]. Ambulas has the similar idea by expressing '4' as *nakwasa* = *nak* + *waasa* '1 dog' [68]. Another Papuan language, Igom, uses word *rumangga* 'pig' as an alternative number for the same numeral.

An interesting observation is found in the Austronesian words for '3' and 'egg'. There are several examples of this pair of words from different languages, as follows: Nggela – *tolu* / *tolu* [20]; Bima – *tolu* / *dolu*; Sika and Kemak – *telu* / *telo*; Southeast Babar – *wo-kely* / *kely*; Bonfia – *toli* / *tolin*. Such languages as Mangarai, Ngadha, Lio, Kambera, Geser, Soboyo have the same words for both '3' and 'egg'.

Ornithologists would confirm that the usual seagull egg laying consists of three eggs. The author will assume that there is a relationship between the number '3' and the quantity of eggs laid by a seagull.

Another discovery is the similarity of the words 'four' and 'stone', all found in the same several languages of Austronesia. Perhaps, it was the 'stone' that served as the source for determining the number '4'. One would wonder why this word was taken. Either Austronesians traditionally use four stones as a support for a cooking pot or had some sort of ritual connected with four stones. Finally, it could be used in a game. For example, Stewart Culin described the ancient game *lu-lu*, which was played by Hawaiians. It was a kind of dice game, known to Europeans, for counting dots that were marked on four disks of volcanic stone [14]. Of course, this game most likely appeared after the word 'stone' turned into the term 'four'. Otherwise, what would they call the number '4'?

Be that as it may, let us take a look at the examples of pairs of words 'four' / 'stone' in the languages of the Solomon Islands: Nggela *vati* / *vatu* [20]; Tandai, Ndi, Ghari, and Talise *vati* / *vatu*; Longgu *vai* / *vau*; Marau, 'Are'are, and Sa'a *hai* / *hau*; and To'ambaita, and Fataleka *fai* / *fau* [62].

<sup>8</sup> Pictures from Internet sources: silver-katze.blogspot.com, freepng.ru, ck.ot7.ru (accessed 20 February 2020).

What deserves attention as well is the numeral '6' in Polynesian languages such as Rapanui, Marquesan, Tahitian, Hawaiian, Maori, and Mangareva, wherein they count '6' as *ono*, which sounds close to 'turtle' *honu*. The languages of the Solomon Islands show similar matches. See examples of pairs of words 'six' / 'turtle' from the above-mentioned languages as well: Nggela *ono* / *vonu*, *vono* [20]; Tandai, Ndi, Ghari, and Talise *ɔnɔ* / *vonu*; Longgu *ɔnɔ* / *vonu*; 'Are'are *ōno* / *hōnu*; Marau, and Sāa *ono* / *honu*; and To'ambaita, and Fataleka *ɔnɔ* / *fōnu* [62].

One should keep in mind that the number '5' in Austronesian means 'hand', and thus we can assume that a long time ago the Austronesian people solidified the abstract meaning of quantity by means of simple and vivid words: '1', '2', egg = '3', stone = '4', hand = '5', and turtle = '6'. Now this associative row looks as follows (Fig. 2):



Figure 2. The associative row of numerals

This pattern is not valid for Algonquian, but it seems like a coincidence that the same pair of words, '6' and 'turtle', occur in the Eastern Algonquian language Powhatan. Albert Gatschet (per Strachey, Smith, and others) supplied the following entries in his 1893 vocabulary: *comotinch* '6' (phonemic /ka-mərənč(?)/ from Proto-Eastern Algonquian /*\*aka-mərənč*/ 'at the finger at the other side' [49], or 'contrary or opposite thumb [or hand, finger]') and *commotins* (*accomodemsk*) 'turtle' (no etymology offered, but -ns means 'little'); thus, Algonquianists regard these words as having different origins.

Another sample has been found in So, a Mon-Khmer language, in which the numeral '6' *tapət* can be compared with 'turtle' *pi:t* [43].

In the Kwaio of Malaita one can find the numeral '8' *kʷalu* and 'octopus' *kʷala* [34]. This makes it possible to continue the associative row of Austronesian languages mentioned above. However, it can be the opposite way of borrowing, as we have, for example, Old Russian '8' *osm* and 'octopus' *os'minog*. The only difference between Russian and Austronesian is that the latter knew octopuses before any calculations started.

'Twenty' is a word meaning 'crocodile' in some Ndu family languages of New Guinea.

'Eighty' *ɲkùù* etymologically means 'chicken' in the Supyire Senufo of Mali. One can assume that it was the price of a chicken at some time in the past [10].

Animal names occur in the numeral systems of North American languages, such as Atakapa ('hog') and Chitimacha ('rabbit'), where the terms are used in expressing 'a hundred'. The Chitimacha term for 'rabbit, a hundred' *puup* has in turn been borrowed as a loanword meaning 'hundred' into Natchez, where it is semantically opaque [23].

The Nivkh word for 1,000 *n'əmqa* can be compared with *n'əmχ* 'mosquito'. The same word for 'a thousand', *kukurei*, has the additional meaning of 'domestic fowl' in the Buin language of the Bougainville Islands.

In the Eastern Karaboro language of Burkina Faso, the word *nà?ā* used for '2,000' means actually 'cow' because this was the price for a cow a long time ago.

In the language of Rwanda, 10,000 is *inzovu*, or 'an elephant'; 100,000 is *akayovu* or 'a small elephant'; and 100,000,000 is *impyisi* or 'a hyena'.

Ancient Egyptian has a tadpole hieroglyph to express '1,000,000'.

The greatest number expressed by an animal name is  $10^{48}$ , that is, 1 with 48 zeroes. In Old Russian, this number was designated by the word *voron* or *vran* 'raven'.

It has already been mentioned that there are several unusual numerals in Sanskrit (such as 'a wing', 'an eye', and 'a hand' as the number two). In ancient Indian texts there are many allegories used instead of numerals. There is a complex system of using certain words associated in one way or another with a substituted number.

For example, instead of unity, such words as "sun" or "moon" could be used, since they exist in a single form. One can find over 40 options for the number 'one'. At least 30 word variations were used for the number 'two'. The number 'three' could be replaced with such words as "fire" (for which the Indians distinguished three types), and "eye" (a reference to the three eyes of Shiva). Instead of 'four' they used the word "water" because in those days four seas were distinguished. The word "elephant" was used instead of the number 'eight' because it was believed that eight elephants support the sky [54].

There are different numeral classes in some languages for various objects in counting, such as human beings, animals, and long or flat objects. For example, Chambri (New Guinea) has five classes; Tsimshian (North America), seven; and Nivkh (Sakhalin), 26. A good example is the numeral '2' in the various classes of Abau (New Guinea): *pris* (humans), *inres* (branches), *nares* (round objects), *ses* (fires), and so on [45].

Other languages for the same purpose use special words called "numerators". For example, Tongan (Polynesian) '3' is *tolu*, but '3 (men)' is *toko-tolu*, with *toko* being the human-class numerator. Numerators are also met in Turkic, Indonesian, and other languages. Chinese has more than 10 numerators, Japanese has no less than 30, and Mayan has about an astounding 80.

Various constructed language projects (conlangs) can supplement this list of numeration classes. *Thaathmuul* uses a number system based on one; *Minbari* in the show *Babylon 5* and *Lamanā* use base-11; *Machi* of Terrence Donnelly as well as *Beftokan* and *Xaceri*, 14; *Muplo* of Max Yurtsev, 17; *Methaiun* of Mark Rosenfelder as well as *Dijineko* and *Tyntha* use base-18; *Vocatae* (Foxish) of Nicholas Bridgewater, base-19; and *Aspectis*, 22. *Ithkuil* of John Quijada uses the centesimal number system, which means based on 100; Jeffrey Henning in his *Fith* uses a system based on 144. Finally, Tom Breton, the author of *AllNoun*, declares so-called zero-based counting in this conlang, all words of which are nouns.

Of especial interest are those separate numerations used by professionals and by children. Below, several examples are listed by way of conclusion.

An old system of alleged and unproved counting of sheep in Welsh (Brythonic Celtic), Keswick [48]:

1 <i>yan</i>	6 <i>sethera</i>	15 <i>bumfit</i>
2 <i>tyan</i>	7 <i>lethera</i>	
3 <i>tethera</i>	8 <i>hovera</i>	
4 <i>methera</i>	9 <i>dovera</i>	
5 <i>pimp</i>	10 <i>dick</i>	

Karachay-Balkar (Turkic) money counting (obsolete) [35]:

5 kopecks <i>bir şai</i>	25 kopecks <i>beş şai; qara som</i>
10 kopecks <i>eki şai</i>	50 kopecks <i>somdžarım</i>
15 kopecks <i>üç şai</i>	10 rubles <i>tümen</i>
20 kopecks <i>tört şai; apas</i>	



Counting songs that are sung by Nyanja (Bantu) children when playing counting games [4]:

			Usual method
1 <i>dazi</i>	<i>dazi</i>	<i>kamba</i>	- <i>moji</i>
2 <i>tondola</i>	<i>pakakhala</i>	<i>nadya</i>	- <i>wili</i>
3 <i>peleka</i>	<i>palombe</i>	<i>mbuna, mbuna</i>	- <i>tatu</i>
4 <i>mazanga</i>	<i>panagona</i>	<i>tangela</i>	- <i>nai</i>
5 <i>piliwili</i>	<i>nkhwali</i>	<i>ana</i>	- <i>sano</i>
6 <i>milomo</i>	<i>milomo</i>	<i>kuno</i>	- <i>sano ni -moji</i>
7 <i>canjali</i>	<i>pembela</i>	<i>kulila</i>	- <i>sano ni -wili</i>
8 <i>calela</i>	<i>kwangali</i>	<i>ngondo, ngondo</i>	- <i>sano ni -tatu</i>
9 <i>zintali</i>	<i>litolo</i>	<i>bambo</i>	- <i>sano ni -nai</i>
10 <i>khumi</i>	<i>likhumi</i>	<i>cilingalilee</i>	<i>kumi</i>

Counting in games in Olevuga (I), in comparison with standard Nggela (II) (Florida Islands, Melanesian):

I	II
1 <i>eta, tea</i>	<i>sakai, si, keha</i>
2 <i>ura</i>	<i>rua, ura, ruka</i>
3 <i>lotu</i>	<i>tolu</i>
4 <i>tavi</i>	<i>vati</i>
5 <i>nila</i>	<i>lima</i>
6 <i>noa</i>	<i>ono</i>
7 <i>tivu</i>	<i>vitu</i>
8 <i>rau</i>	<i>alu</i>
9 <i>beta</i>	<i>hiua</i>
10 <i>talari</i>	<i>hanavulu</i>

## Conclusion

Naturally, it is impossible to include every existing counting system in this article. One can easily see that every manner of numeration here may be divided into further subsystems. Although the total number of such systems is no match for the many thousands of languages presently spoken, hopefully, even these several tens of examples can show the full breadth of the problem of counting and can also help one to understand how many conceptually abstract methods had been employed by the original speakers of various protolanguages – patterns still maintained by their descendants. One can imagine how extraordinarily inventable different civilizations have been in this seemingly small problem of defining quantity.

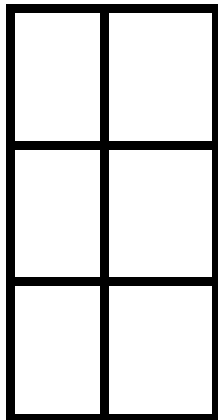
Comparing the structure of high numbers in decimal counting systems demonstrated that grouping by base is not final. This study can be continued in that direction. On the other hand, there are differences in the numeration found even in closely related languages, as one could see it in the case of number '90', which has different structure in Russian as opposed to other Slavic languages.

All stated above leads one to further studies in translation between languages that use different counting systems. The original hypothesis of using associative rows of numerals in the Austronesian languages is waiting for comments as well. This topic is open for discussion and further research.



Appendix A  
On a version of counting by '9'<sup>9</sup>

Designations:

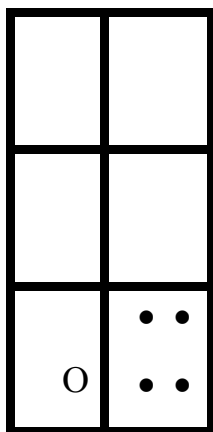


= Hundreds rank (3)

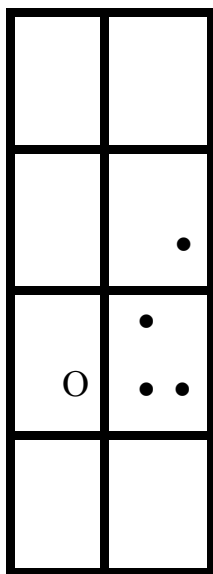
= Tens rank (2) a clay table, *abak*

= Unity rank (1)

o = Plum stone, meaning '5'  
• = Cherry stone, meaning '1'

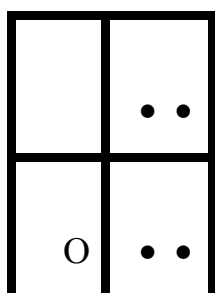


'9' ('1 nine') All stones are in the unity rank. We read '9'.



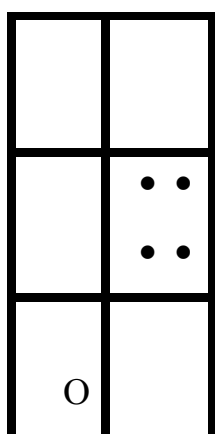
'18' ('2 nines')  $\underline{2} \times 9$  means ( $\underline{2} - 1$ ) stones go to the next rank.

<sup>9</sup> The source of this hypothetical scheme of using the nonary trade-numeral system is at present unavailable.

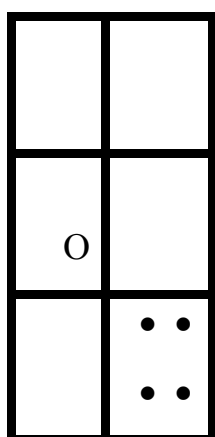


'27' ('3 nines')  $\underline{3} \times 9$  means ( $\underline{3} - 1$ ) stones go to the next rank.

For multiplication "9" on "X" we must move "X - 1" stones.

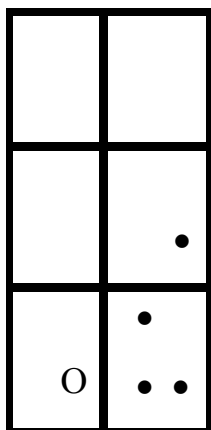


'45' ('5 nines')

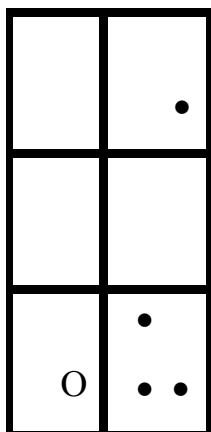


'54' ('6 nines')

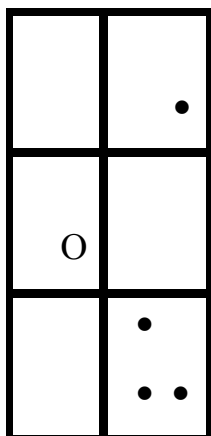
And so on. For example, to multiply  $9 \times 17$  we need to move  $17 - 1 = 16$  stones. However, we have only 9, one might say. The point is that the passage at the 1-2 rank gives unities; one at the 2-3 rank gives tens; one at the 3-4 rank gives hundreds; and so forth. Thus in our case we move stones in the consecutive order as shown below:



Count '1' (from 16).



Count '11'.

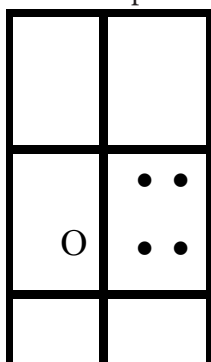


100

50 Count '16'; that is, the result is 153.

3

It is easy to see that we cannot multiply  $9 \times 11$  by means of four cherry stones and one plum stone only; thus this operation looks as follows:



$9 \times 10 = 90$

O	• • • •
O	• • • •

$$90+9 = 99$$

## Appendix B

### Systems of birth-order names

There are **systems of birth-order names** with separate terms for male and female children in Indo-Pacific, Austronesian, Australian, African, and Amerindian languages. They represent neither real numeral sequences nor numerical classifiers, but they show an interesting aspect of sequencing. Here are some examples.

Austronesian Manga-Buang in Morobe District [27]:

	<b>Sons</b>	<b>Daughters</b>
first born	<i>tuk</i> [tʊk]	<i>mɔːg</i> [mɔːʔ]
second born		
third born	<i>gwey</i> [ˈɣwey]	<i>ɓarek</i> [ɓaɾɛːk]
fourth born	<i>rɛ:y</i> [rɛ:y]	<i>da:bi</i> [ˈdaːbi]
fifth born		
sixth born		
seventh born		<i>gɔːɓ</i> [ɣɔːɓ]
	(fricative uvular g = ɣ)	

Austronesian Central Buang [30]:

	<b>Sons</b>	<b>Daughters</b>
first born	<i>Aguu</i>	<i>Mewing</i>
second born	<i>Amon</i>	<i>Anii</i>
third born	<i>Gwee</i>	<i>Velek</i>
fourth born	<i>See</i>	<i>Dabi</i>
fifth born	<i>Guu</i>	<i>Sěj</i>
sixth born	<i>Bewě</i>	<i>Tamu</i>
seventh born	<i>Meggi</i>	<i>Pahoov</i>
eighth born	<i>Dahisoong</i>	<i>Len</i>
ninth born	<i>Kele ris</i> ‘tree leaves’ for any children beyond eight	

The system of seven birth-order names in some Austronesian Malayan districts [64]:

	<b>Sons</b>	<b>Daughters</b>
first born	<i>Sulung</i> 'oldest'	Using prefix <i>Meh</i>
second born	<i>Awang</i> 'friend, comrade'	
third born	<i>Idam</i> 'black'	
fourth born	<i>Puteh</i> 'white'	
fifth born	<i>Allang</i>	
sixth born	<i>Pendeh</i>	
seventh born	<i>Kechil</i> 'little one', the youngest'	

Austronesian Kaugel Valley children's or sibling's birth order [8]:

first born	<i>komono</i>
second born	<i>sukuamo</i> 'middle, or next-born'
third born	<i>yepoko sipemo</i> 'third-born'
fourth born	<i>kise sipemo</i> 'fourth-born'
fifth born	<i>akilyomo</i> 'last-born'

The following is the nine birth-order system of the Parnkalla (Pangkala, Banggarla) language of southern Australia [52].

	<b>Sons</b>	<b>Daughters</b>
first born	<i>piri</i>	<i>kartanye</i>
second born	<i>wari</i>	<i>wayuru</i>
third born	<i>kunni</i>	<i>kunta</i>
fourth born	<i>munni</i>	<i>munnaka</i>
fifth born	<i>marri</i>	<i>marrukko</i>
sixth born	<i>yarri</i>	<i>yarranta</i>
seventh born	<i>milly</i>	<i>méllakka</i>
eighth born	<i>wangguyu</i>	<i>wanggurtu</i>
ninth born	<i>ngallai</i>	<i>ngallka</i>

The curious point is that in their normal counting the Parnkalla speakers use three numerals only: *kubmanna* '1', *kuttara* '2', and *kappo*, or *kulbarri* '3, or several' [52].

Below is a similar system of five birth-order names present in the Siouan languages of Sisseton-Wahpeton Dakota, living in North Dakota, and then Hoocak (Winnebago) in Wisconsin.

	<b>Male</b>	<b>Female</b>
first born	<i>Caske</i> ( <i>c</i> = [č])	<i>Winuna</i>
second born	<i>Hepan</i>	<i>Hapan</i>
third born	<i>Hepi</i>	<i>Hapistinna</i>
fourth born	<i>Catan</i>	<i>Wanske</i>
fifth born	<i>Hake</i>	<i>Wihake</i>

If the first child born to a couple were a male, he would be called Caske, if the next child were a female, she would be named Hapan. Their real names are sacred and so not used in speaking. Notice that these names do not correspond to the Dakota count numerals: *wan̄ca*, *nōpa*, *yamni*, *topa*, *zaptan̄* [22].

Hoocąk (Ho-čągra, Hochunk, Winnebago), a language of the Chiwere Siouan subgroup of eastern Wisconsin [29]:

	Male	Female
first born	<i>Kųųnų́</i>	<i>Hűnų</i>
second born	<i>Heeną</i>	<i>Wűiha</i>
third born	<i>Haagá</i>	<i>Haksiíga</i>
fourth born	<i>Nąąǵi</i>	<i>Hinąąke</i>
fifth born	<i>Nąąǵixųnų</i>	<i>Haksiígaxųnų</i>
sixth born	—	<i>Hinąkéxųnų</i>

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**About the author:**

**Pavel Petrov** is an independent researcher from Kaliningrad, Russia. Research interests: linguistics, counting systems, constructed languages. E-mail: pavelpetrov2000@yahoo.com

**Сведения об авторе:**

**Павел Васильевич Петров** – независимый исследователь из г. Калининграда, Россия. Сфера научных интересов: лингвистика, системы счёта, конструированные языки. E-mail: pavelpetrov2000@yahoo.com

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