The typology of Pamean number systems and the limits of Mesoamerica as a linguistic area

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Abstract

Pamean languages have been considered to be outside of the Mesoamerican linguistic area. However, the number systems of Pamean show typical Mesoamerican structures: order of constituents Multiplier-Base-Addend, and systems with bases 10 and 20. Pamean languages have a typologically unusual, but consistent base 8. The present study presents a formal characterization of Pamean number systems. The distribution and peculiarities of Pamean number systems are explained as a result of their location at the border of a major linguistic area. Northern Pame has 8 as the only productive base, whereas Central Pame and Southern Pame show a greater influence of Mesoamerican traits.

Keywords: *cardinal numerals, linguistic area, Mesoamerica, number systems, numeral, Pamean*

1. Introduction

In this article I present an analysis of the cardinal number systems of the Pamean languages Northern Pame, Central Pame and Southern Pame. My goals are twofold. First, I offer a formal characterization of Pamean number systems in terms of the typology of number systems. Second, I discuss the particularities of Pamean number systems as a result of their location at the border of a major linguistic area, Mesoamerica.[1] I show that Pamean systems present typical Mesoamerican structures with the order of constituents Multiplier-Base-Addend and with bases 10 and 20. However, Northern Pame is of special interest for the typology of number systems owing to the consistent use of a base 8.

1. As defined by archaeologists, Pamean languages are spoken in the cultural area known as Arid-America or the Gran Chichimeca: see Di Peso (1974) and Kelly (1966) for classic approaches, and several essays in Reyman (1995) for more recent studies.

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Remarkably, in Northern Pame 8 is the only productive base of the system, which is crosslinguistically rather unusual.

Pamean number systems confirm the notion of Mesoamerica as a linguistic area as presented by Campbell, Kaufman, & Smith-Stark (1986) and Smith-Stark (1994). More specifically, Pamean languages support the areal division based on number systems in Barriga Puente (1998) in the following sense: the most northern Pamean language, Northern Pame, has the fewest similarities to Mesoamerican number systems; conversely, the Central Pame and Southern Pame languages exhibit a strong influence of Mesoamerican patterns. The general picture of Pamean shows a mixed system sharing the bases 8 as well as the bases 10 and 20. This is consistent with the hypothesis of Pame dialectology advanced in Avelino (1997) separating three different languages: Northern, Central, and Southern Pame.

2. The Pamean languages

Figure 1 shows the place of Pamean languages within Otopamean, the most northern branch of the Otomanguean family, and Map 1 shows the location of Pamean and Chichimec languages.

For many years there was considerable confusion about the identification of Pamean languages. Often, the names of other Otopamean languages, namely Chichimec and Otomí, were used indistinctly to refer to Pamean languages. Soustelle (1937) includes a discussion of the internal grouping, but Bartholomew (1963) is the earliest controlled dialectological study of Pamean languages. Avelino (1997) is the first linguistic account of previously undescribed Northern Pame. With the information provided by Northern Pame, the modern division of Pamean languages has been established. It is further confirmed by the present study.

Only Northern Pame and Central Pame are still spoken.[2] Southern Pame, now extinct, was spoken in Jiliapan in the State of Hidalgo (Manrique Castañeda 1964). The number of speakers of Pamean languages is uncertain. According to the most recent Mexican census there are 8,312 speakers of Pame (INEGI 2000). However, the number could be less since many self-declared ethnic Pame people do not speak the language. Likewise, the census does not make further distinctions of internal variation among the Pamean languages.

2. The surviving Pamean languages are spoken in the northeast of Mexico in the states of San Luis Potosí, and Central Pame is also spoken in Querétaro. The *municipios* where Central Pame is spoken are Santa Catarina and Aquismón; Northern Pame, an undescribed language before Avelino (1997), is spoken in the *municipios* of Tamasopo, Rayón, Villa del Maíz, and Cárdenas. The varieties represented in this paper include the localities of Paso de Botello, Las Jaritas, and Cuesta Blanca. Chichimec is only spoken in the community of Misión de Chichimecas in the state of Guanajuato.

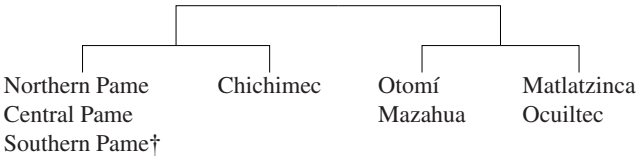
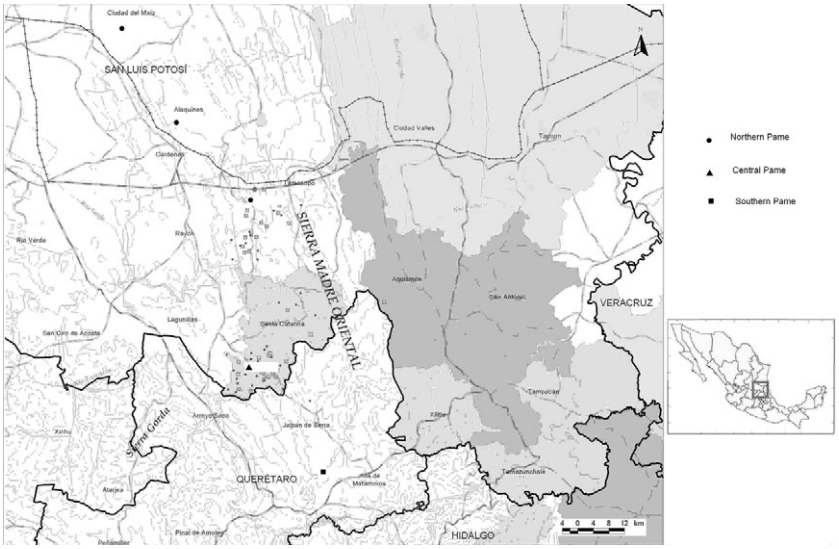


Figure 1. *Internal division of Otopamean languages*



Map 1. *Location of Pamean and Chichimec languages*

The two surviving Pamean languages differ in many aspects of the phonology and grammar and crucially are not mutually intelligible. However, internally each of the two languages constitutes a chain of dialects differing in several minor aspects of the grammar as well as in the number systems.[3]

3. Formal typological characterization of Pamean number systems

The formal apparatus that I will use to describe Pamean number systems is based on that of Barriga Puente (1998), which is the most important typological survey of American Indian number systems. According to Barriga Puente number systems can be divided into three major groups: (i) non-based systems,

3. More research is needed to establish the further internal divergence of the Pamean languages.

(ii) somatic systems, and (iii) based systems. Based systems can be further classified according to the number of bases used in the organization of counting. Thus, there are monobasic, dibasic, tribasic systems, and so on. A more refined classification is possible if the following criteria are considered: (i) basic operation,[4] (ii) position of addend, multiplier, and subtrahend relative to the base, and (iii) perspective, i.e., whether the system is prospective or retrospective. The possibilities just mentioned are not mutually exclusive; in fact we will see that Pamean number systems present features of both a somatic and a based system.

Table 1 gives the numbers in the three Pamean languages. It is important to note that the pattern of Central Pame is quite productive in the sense that speakers can use the structures recursively to form high numbers, and most of the speakers know and use the lowest numbers. In contrast, Northern Pame numbers are, at the present time, unused structures: few speakers remember numbers up to '5' or '8', and the longest list that I could find ran up to '32'.

3.1. *Monolexemic numbers*

Greenberg's Universal No. 4 claims that every language has non-derived lexical forms for some numbers: "In every numerical system some numbers receive simple lexical representation" (Greenberg 1978: 255). The lowest numbers considered to be monomorphemic, and the only ones found in both Central Pame and Northern Pame, are *nda* and *santa* 'one', *nuj* and *nuji* 'two', and *ranhũʔ* and *rnuʔ* 'three', respectively.[5]

3.2. *Semiproductive structures*

After '3', Central and Northern Pamean languages make use of semiproductive structures using a form *ki-*, which has a general meaning of duality.[6] For '4',

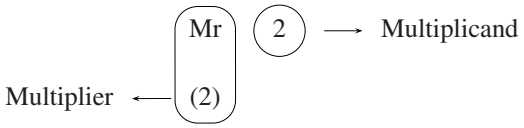
4. By basic operation I mean basic arithmetic operation: addition, subtraction, multiplication, and division.
5. As to be discussed in Section 3.3.2, the numbers '8', '100', and '1000' are based on the root *-tsaw*; the prefix *n-* occurs in '8' and '100', and *ra-* occurs in '1000'. Therefore, these numbers cannot be considered strictly monomorphemic.
6. Two reviewers have noticed that there may be a problem identifying *ki-* as a marker of dual. In fact, it should be noted that the regular dual suffix on nouns and verbs is *-i*. The form *ki-* is not attested anywhere else with the meaning of dual, nor is it found in related Otopamean languages. However, an abstract meaning of dual is the only interpretation that makes sense in these numerals. In this respect, Bernard Comrie pointed out that in some languages there are morphemes that occur only with few words, crucially with words for numbers, as in the Japanese indigenous numeral system. In this system there are instances of "pairing" by means of consistent vowel changes, which is nowhere else used as a marker of dual. Consider the following pairs: '1' *hito*, '2' *huta*; '3' *mi*, '6' *mu*; '4' *yo*, '8' *ya*; '5' *itu*, '10' *to*. These examples show that the last pair does not follow exactly the vowel alternation (*u-o* instead of regular *i-u*, *o-a*, and there is an initial *i-* in '5').

Table 1. *Pamean number systems*

English	Central Pame	Northern Pame	Southern Pame
'one'	*nda*	*sante*	*nna*
'two'	*nui*	*nuji*	*ti*
'three'	*ranhũʔ*	*rnuʔ*	*nijû*
'four'	*kiɲui*	*giriui*	*tipijâ*
'five'	*kik'ai*	*gitʃ'ai*	*ʃpotûnt*
'six'	*tilija*	*teria*	*tikijen*
'seven'	*tiliɲũhũɲ*	*teriuhiɲ*	*tekiti*
'eight'	*nda ntsawʔ*	*tenhiuɲ*	*tei^{h}njûn*
'nine'	*nda ntsawʔ nda*	*kara tenhiuɲ santa*	*nahwên*
'ten'	*seskaʔai*	*kara tenhiuɲ nuji*	*stut'u*
'eleven'	*seskaʔai nda*	*kara tenhiuɲ rnuɲ*	*stut'utonna*
'twelve'	*seskaʔai nui*	*kara tenhinɲ giriu*	
'thirteen'	*seskaʔai ranhũʔ*	*kara tenhinɲ gitʃ'ai*	
'fourteen'	*seskaʔai kiɲui*	*kara tenhinɲ teria*	
'fifteen'	*seskaʔai kik'ai*	*kara tenhinɲ teriuhiɲ*	
'sixteen'	*seskaʔai tili ʔja*	*kanuje tenhiuɲ*	
'seventeen'	*seskaʔai tiliɲũhũɲ*	*kanuje tenhiuɲ sante*	
'eighteen'	*seskaʔai nda ntsawʔ*	*kanuje tenhiuɲ nuji*	
'nineteen'	*seskaʔai nda ntsawʔ nda*	*kanuje tenhiuɲ rnuʔ*	
'twenty'	*nda lien*	*kanuje tenhiuɲ giriui*	
'twenty one'	*nda lien nda*	*kanuje tenhiuɲ gitʃ'ai*	
'twenty two'	*nda lien nui*	*kanuje tenhiuɲ tiria*	
'twenty three'	*nda lien ranhũʔ*	*kanuje tenhiuɲ teriuhuiɲ*	
'twenty four'	*nda lien kiɲui*	*karnuʔ tenhiuɲ*	
'twenty five'	*nda lien kik'ai*	*karnuʔ tenhiuɲ santa*	
'twenty six'	*nda lien tiliʔja*	*karnuʔ tenhiuɲ nuji*	
'twenty seven'	*nda lien tili ɲũhũɲ*	*karnuʔ tenhiuɲ rnuʔ*	
'twenty eight'	*nda lien nda ntsawʔ*	*karnuʔ tenhiuɲ rnuʔ*	
'twenty nine'	*nda lien nda ntsawʔ nda*	*karnuʔ tenhiuɲ gitʃ'ai*	
'thirty'	*nda lien seskaʔai*	*karnuʔ tenhiuɲ tiria*	*nadetist'û*
'thirty one'	*nda lien seskaʔai nda*	*karnuʔ tenhiuɲ tiriuhiɲ*	
'thirty two'	*nda lien seskaʔai nui*	*giriuį̂ tenhiuŋ*	
'thirty three'	*nda lien seskaʔai ranhũʔ*		
'thirty four'	*nda lien seskaʔai kiɲui*		
'thirty five'	*nda lien seskaʔai kik'ai*		
'thirty six'	*nda lien seskaʔai tili ʔja*		
'thirty seven'	*nda lien seskaʔai tili.ɲũhũɲ*		
'thirty eight'	*nda lien seskaʔai nda ntsawʔ*		
'thirty nine'	*nda lien seskaʔai nda ntsawʔ nda*		

English	Central Pame	Northern Pame	Southern Pame
'forty	*nui lien*		*tide*
'forty one'	*nui lien nda*		
'forty two'	*nui lien nui*		
'forty three'	*nui lien ranhũʔ*		
'forty four'	*nui lien kiɲui*		
'forty five'	*nui lien kik'ai*		
'forty six'	*nui lien tiliʔja*		
'forty seven'	*nui lien tiliɲũhũɲ*		
'forty eight'	*nui lien nda ntsawʔ*		
'forty nine'	*nui lien nda ntsawʔ nda*		
'fifty'	*nui lien seskaʔai*		*tidest'u*
'sixty'	*ranhũʔ lien*		*niyûde*
'seventy'	*ranhũʔ lien seskaʔai*		
'eighty'	*kiɲui lien*		*tipiyâde*
'ninety'	*kiɲui lien seskaʔai*		
'one hundred'	*nda ntswaʔ*		*ñant'e*
'one hundred ten'	*nda ntswaʔ seskaʔai*		
'one hundred twenty'	*nda ntswaʔ lien*		
'two hundred'	*nui ntswaʔ*		*tint'e*
'three hundred'	*renhũʔ ntsawʔ*		*njûnt'je*
'four hundred'			*tipjêt'je*
'one thousand'	*nda ratsawʔ*		*stut'ut'je*

the dual morpheme multiplies the stem of '2', in other words, it is a 2×2 operation. This strategy is formalized in Barriga Puente's notation as follows: the multiplier 2 is specified below the abbreviation 'Mr' (for "Multiplier"), then the multiplicand follows it. In Southern Pame the formation of '4' uses the numeral '2', *ti*, as equivalent to the *ki-* form in Central and Northern Pame.



Thus, '4' in the three languages is composed by a 2×2 operation as exemplified in (1):

(1)	Central Pame	Northern Pame	Southern Pame	meaning
	ki-ɲui	*gi-riui*	*ti-pijâ*	
	DUAL-two	DUAL-two	2-two	'four'

Further support for this analysis comes from the closely related language Chichimec, which employs the same strategy of affixing the dual morpheme to a number stem. According to Bartholomew (1969: 283), in this language '4' "is formed on the base for '2' plus a prefix", significantly, Bartholomew also notes that '2' in Chichimec and Southern Pame "contains the grammatical dual suffix: *-s* in Chichimec, *-i* in Pame [Jiliapan]" [my translation – HA].

The formation of the number '5' utilizes the very same operation in Central and Northern Pame, although here the notion conveyed by the dual morpheme is 'one half' which is multiplied with the number '10' expressed by the root for 'hand', *-k'ai* (Central Pame) and *-tʃ'ai* (Northern Pame). One possible analysis of these forms is that the fundamental operation is not multiplication but division, so that '5' would express '10/2'. Nonetheless, there are reasons for rejecting this approach. First, universals of number systems suggest that supposed instances of division are really cases of multiplication. This is the central theme of Greenberg's Universal No. 16: "Division is always expressed as multiplication by a fraction. Only units or multiples of units are dividends, and the denominator of the fraction is always 2 or a power of 2" (1978: 261). Second, in the survey of Barriga Puente (1998) there is no system where a non-basic numeral is built up by division, and in which the divisor is a whole number.[7] Third, it is very unlikely that the same morpheme indicating the meaning of 'duality' is used to express two different, and actually opposed, operations in two consecutive numbers (multiplication and division); it seems reasonable to preserve one single operation and configuration for both '4' and '5'.[8] These arguments support the analysis of multiplication as the active operation in composing '5' in Pame number systems. In (2) I show the representation of '5'.

(2)	Central Pame	Northern Pame	operation	meaning
	ki-k'ai	*ki-tʃ'ai*	Mr 10	
	DUAL-hand	DUAL-hand	(1/2)	'five'

In addition, supporting this analysis, we should note that the somatic feature found in Pame is shared by other languages in the Otopamean family. As pointed out by Bartholomew (1969: 283), "Number 'five' is related to 'ten' in all the (Otopame) languages [...] In Northern Pame and all the southern languages [within Otopamean] the main morpheme is 'hand' ".

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7. Thanks to Francisco Barriga for pointing this out.
8. There is a question why, with a consistent base 8, '10' should involve '5' as in 'half of the ten'. Bernard Comrie suggests the very plausible hypothesis that the somatic motivation for the number may outrank the arithmetic, i.e., 'half of two hands' is a better way to express '5' than a relatively more complex operation dividing the sum of 8+2.

3.3. *Productive structures*

3.3.1. *Base 5.* Greenberg's Universal No. 36 states that "[t]he only number expressions deleted are those for 1 and for bases of the system" (1978: 278). It is accordingly possible to affirm that 5 constitutes a legitimate base in Pamean languages, assuming that in the following three numbers, '6', '7', and '8', the immediate preceding base 5 is omitted; then, '1', '2', and '3' follow the connective. A faithful gloss for '6', '7', and '8' could be something like 'and 1', 'and 2', 'and 3', all of them with an entailed '5' expressed in parentheses below.

(3)	Central Pame	Northern Pame	operation	meaning
	tili-ʔja	*teri-ʔja*		
	CONNECT-one	CONNECT-one	(5) + 1	'six'
	tili-ɲũhũŋ	*teri-uhiŋ*		
	CONNECT-two	CONNECT-two	(5) + 2	'seven'
		ten-hiuŋ		
		CONNECT-three	(5) + 3	'eight'

The formula for the strategy in (4) specifies the elided number in parenthesis just as in (3) above, then comes the symbol for addition and the addend expressing the upper limit of the counting in a superscript. Thus, in Central and Southern Pame the exponent is 2 since '1' and '2' are employed to form '6' and '7'; in Northern Pame the exponent goes up to 3 because '8' is also composed by this mechanism. The complete representation of those numbers using base 5 in all three languages is seen in (4).

(4)	Northern Pame	Central Pame	Southern Pame
	(5) + Add^{3}	(5) + Add^{2}	(5) + Add^{2}

This pattern is not merely a Pamean idiosyncrasy, but present in all of Otopamean, as is evident in (5). Never in any of the other languages of the group are '6' or '7' monolexemic, but there is a tendency to derive them from an elided base 5. It should be mentioned also that in contrast to Pamean, in Otomí, Mazahua, Matlatzinca, and Ocuiltec the order of constituents is Addend-Connective (Bartholomew 1969: 286).

(5)	Otomí	Mazahua	Matlatzinca	Ocuiltec	meaning
	ʔnah-to	*ʔñan-to*	*daha-toho*	*mbla ndoho*	
	one-CONNECT	one-CONNECT	one-CONNECT	one CONNECT	'six'
	yoh-to	*yen-čo*	*nehe-toho*	*mye ndoho*	
	two-CONNECT	two-CONNECT	two-CONNECT	two CONNECT	'seven'

3.3.2. *Base 8.* Pamean languages differ from Otomanguean (and not only from these) in having base 8. In Central Pame this is seen in the numbers '8' and '9': '8' is 'one eight', and '9' means something close to 'one eight plus one' as shown in (6).

(6) *nda ntsaw?*
one (times) eight 'eight'
nda ntsaw? nda
one (times) eight (plus) one 'nine'

This analysis of '8' and '9' offers further support for assuming a true base 8. Greenberg has claimed in Universal No. 25 that "[o]nly a base is ever multiplied by 1" (1978: 271), as indeed happens in Pamean. I will show below that in the external syntax of numerals the multiplier precedes the base, like in (6), where '1' is in the multiplier position and '8' follows.

Other accounts of Pame dialects confirm the validity of a base 8. Bartholomew (1969: 284) suggests that "ten is eight plus two" in Gamotes Pame.[9] From this source it can be observed that the system in Gamotes follows the same procedure as described above, although in this language the counting is extended up to '10'. The Gamotes data in (7) show the omitted base 5 in the formation of '8', after that a new connective and the addend are used in order to count '9' and '10'.

(7)	*teri-ʔya*			
	CONNECT-one		(5) + 1	'six'
	te-nuhinʔ			
	CONNECT-two		(5) + 2	'seven'
	te-ñhuhne			
	CONNECT-three		(5) + 3	'eight'
	te-ñhuhʔn	*e-nda*		
	CONNECT-three	CONNECT-one	(5) + 3 + 1	'nine'
	te-ñhuhʔn	*e-nuyi*		
	CONNECT-three	CONNECT-two	(5) + 3 + 2	'ten'

Exemplifying with '9', a corresponding Central Pame numeral is given in (8). The multiplier is specified with a subscript, then the base follows it, and finally the upper limit of the addend is also expressed as a subscript.

(8)	*ndaʔ*	*ntsaw*	*nda*	
	Multiplier_1	8	Add_1	'nine'

9. Gamotes Pame belongs to Central Pame. As is clear from this data, the number system of this dialect differs in some respects from the varieties spoken in Santa María Acapulco, Las Jaritas, and Paso de Botello. However, the two dialects belong to the same language.

Although in Central Pame the base 8 is used only in the configuration of '8' and '9' (and also '10' in some dialects such as Gamotes Pame), in Northern Pame 8 is the core base of the system.

To analyze these facts, first, the fundamental operation on higher numbers is multiplication according to the formula Multiplier x Base which can be seen from multiples of '8' in (9) which could be glossed as 'x times eight'. So, '16' is 'two times eight', '24' is 'three times eight', and '32' is 'four times eight'. Second, intermediate numbers between cycles of the base are expressed introducing an addend. The forms in (9) illustrate this operation. '9' is 'one times eight plus one', '18' is 'two times eight plus two', and '27' is 'three times eight plus three'.[10]

(9)	Multiplier (connective-multplier)	Base	Operator elided (plus)	Addend	meaning
	kara	*tehiuŋ*		*santa*	
	(1	8)	+	1	'nine'
	kanuje	*tehiuŋ*			
	(2	8)			'sixteen'
	kanuje	*tehiuŋ*		*nuji*	
	(2	8)	+	2	'eighteen'
	kanuʔ	*tehiuŋ*			
	(3	8)			'twenty four'
	kanuʔ	*tehiuŋ*		*muʔ*	
	(3	8)	+	3	'twenty seven'
	giriui	*tehiuŋ*			
	(4	8)			'thirty two'

This description provides evidence that the three Pamean languages are similar with respect to the template Multiplier-Base-Addend. However, in Northern Pame the strategy is fully productive. Even though the highest number recorded is '32', nothing precludes the system from extending beyond that limit. If contemporary Northern Pame speakers do not have higher numbers it is not because of a defective system, but due to language loss.

An ethnographic note may help to better understand the Northern Pame system. It is widely observed that languages make use of body part terms to express numbers. Thus, in many languages '20' is related to 'person' or 'a person's head' because the sum of fingers and toes is '20'.[11] Likewise '5' is often

10. These examples can be analyzed as a sequence of the connective *ka-* followed by the multiplier. The form *ka-* does not mean 'one' nor has it an independent meaning. More research is necessary to unveil the meaning of these fossilized forms.

associated with 'hand' because of the counting of five fingers on a hand. In fieldwork with Northern Pame, I noticed that '8' also has a somatic motivation, albeit an unusual one. Instead of counting fingers, some speakers count the knuckles[12] of the closed fist for each hand (excluding the thumb), so that two hands equals eight.[13] Thus, Northern Pame parallels those languages where base 10 is expressed by the term for 'hands'.

3.3.3. *Base 10.* In Central Pame, numbers after '10' follow a decimal pattern, with the addend after the base. Notice that in numbers from '1' to '9', repeated in (10), the decimal system completely preserves the structures of lower numbers as discussed in Sections 3.2 and 3.3. For instance, notice that the only correct interpretation for '16' and '17' is to consider the base 5 omitted. Likewise, the only information available from Southern Pame, as illustrated in (11), indicates a similar structure, the fundamental difference being that the operator is overt in Southern Pame.

(10)

Base	Operator elided (plus)	Addend	meaning
seskaʔai			'ten'
seskaʔai		*nda*	
ten		one	'eleven'
seskaʔai		*nui*	
ten		two	'twelve'
seskaʔai		*ranhũʔ*	
ten		three	'thirteen'
seskaʔai		*kiɲui*	
ten		four	'fourteen'
seskaʔai		*kik ai*	
ten		five	'fifteen'
seskaʔai		*tiliʔja*	
ten		six	'sixteen'

11. Thanks to Lorna Gibson for pointing out that in Central Pame '20' comes from the word for 'people', *lee*, which inflected for 1st person plural is *lyeedn*, because "each one of us people has 20 fingers". Campbell (1979) explicitly claims that the association of '20' with the meaning of 'man' is characteristic of Mesoamerica.
12. For the purposes of this article the knuckles are defined as the joints of the proximal falange with the metacarpal bone.
13. Thanks to Leanne Hinton for the interesting observation that in Yuki the count is based on the spaces between the fingers. An anonymous reviewer points out that there exists anecdotal information from Alfred Kroeber that a Yuki man counted by putting sticks between his fingers, suggesting also a somatic base.

seskaʔai		*tiliɲũhuɲ*	
ten		seven	‘seventeen’
seskaʔai		*nda ntswawʔ*	
ten		eight	‘eighteen’
seskaʔai		*nda ntsawʔ nda*	
ten		nine	‘nineteen’

(11)

Base	Operator	Addend	meaning
stut’u			
ten			‘ten’
stut’u	*to*	*nna*	
ten	plus	one	‘eleven’

3.3.4. *Base 20.* With ‘20’ a new base emerges. The structures described in (12) for Central Pame and (13) for Southern Pame give evidence for a vigesimal base in these languages.

(12)

Multiplier	Base	Addend	meaning
nda	*lien*		‘twenty’
nda	*lien*	*nda*	‘twenty one’
nda	*lien*	*nui*	‘twenty two’
nda	*lien*	*seskaʔai*	‘thirty’
nda	*lien*	*seskaʔai nda*	‘thirty one’
nda	*lien*	*seskaʔai nui*	‘thirty two’
nda	*lien*		‘forty’
ranhũʔ	*lien*		‘sixty’
ranhũʔ	*lien*	*seskaʔai*	‘seventy’
kiɲui	*lien*		‘eighty’
kiɲui	*lien*	*seskaʔai*	‘ninety’

(13)

Multiplier	Base	Addend	meaning
na	*de*		‘twenty’
na	*de*	*tist’û*	‘thirty’
ti	*de*		‘fourty’
ti	*de*	*tist’û*	‘fifty’
niyû	*de*		‘sixty’
tipiyâ	*de*		‘eighty’

First, we can see a multiplier preceding the lexical forms for ‘20’, *lien* and *de*, respectively, as multiples of 20 do. In this sense, ‘20’ is ‘one times twenty’, ‘40’ is ‘two times twenty’, and so on. As we mentioned earlier, according to Greenberg (1978) multiplication by ‘1’ is a universal behavior of bases. Furthermore, the base is multiplied to form higher numbers. The order of numbers

after '20' follows the general Pamean pattern Multiplier-Base-Addend. Furthermore, counting in Central and Southern Pame shows that the addend can itself be complex, as is illustrated with the forms for '31' and '32' in Central Pame where the addends are '11' (ten plus one) and '12' (ten plus two).

Data from Central (14) and Southern (15) Pame show that the structure of numbers higher than '100' follows the general pattern already seen: the multiplier precedes the base and the addend follows the base. For instance, in Southern Pame '1000' is 'ten times hundred'; likewise in Central Pame '110' is 'one times hundred (plus) ten', and '200' is 'two times (one) hundred'.

(14)

Multiplier	Base	Operator elided (plus)	Addend	meaning
nda	*ntsawʔ*			
one	hundred			'one hundred'
nda	*ntsawʔ*		*seskaʔai*	
one	hundred		ten	'one hundred and ten'
nda	*ntsawʔ*		*lien*	
one	hundred		twenty	'one hundred and twenty'
nui	*ntsawʔ*			
two	hundred			'two hundred'

(15)

Multiplier	Base	Operator elided (plus)	Addend	meaning
ñan	*t'e*			'one hundred'
tin	*t'e*			'two hundred'
nɲûn	*t'je*			'three hundred'
tipjê	*t'je*			'four hundred'
stut'u	*t'je*			'ten hundred'

There are some peculiarities with high numbers meriting comment. The form used for '100' in Central Pame is identical to that of '8', namely *ntsawʔ*. Moreover, '1000' has what appears to be the same root, *-tsawʔ*, although it is possible to identify a plural morpheme prefixed to the root, and the nasal present in '8' and '100' is dropped. Once again, the order Multiplier-Base is repeated in '100'. The existence of a separate word for '100', thus, suggests a shift to a decimal system (10^2).[14]

14. Thanks to Bernard Comrie for pointing out that in typical Mesoamerican counting systems '100' is expressed as 5×20.

Table 2. *Summary of Pamean number systems*

	Northern Pame	Central Pame	Southern Pame
Productive Bases	(5) + Add^{3} / Mr 8 Add	(5) + Add^{2} / Mr$_{1}$ 8 Add$_{1}$ / $10^{Mr2,3}$ Add / Mr 20 Add	(5) + Add^{2} / $10^{Mr2,3}$ Add / Mr 20 Add
Semiproductive Bases	Mr 2 (2) Mr 10 (1/2)	Mr 2 (2) Mr 10 (1/2)	Mr 2 (2)

(16)

Multiplier	Base	meaning
nda	*ra-tsaw?*	'one thousand'

That Pamean languages have a mixture of bases 8, 10, and 20 presents a problem for Universal No. 21: "All the bases of a system are divisible by the fundamental base" (Greenberg 1978: 270). In addition, the similarity between '8', '100', and '1000', in contrast with the absence of an arithmetic operation associating the three numbers is striking. One possible explanation is to suppose that the meaning of the stem '8' has shifted to a more abstract sense of 'base', and that such high numbers as '100' and '1000' have borrowed the stem from the lowest base.

To sum up the discussion so far, Table 2 presents the structures discussed in previous sections. The table shows that there are features in common to the three languages, whereas others are only shared by Central Pame and Northern Pame, and some others are unique to Central Pame and Southern Pame. Let us start with the features in common to the three languages. First, all three languages exhibit the structure [Elided Base + Addend] in the configuration of low numbers. In addition, the structure [(5) + Addend] reveals a somatic feature inasmuch as number '5' is related to the root for 'hand' in Central and Nothern Pame.[15] Second, the three languages present Multiplier-Base-Addend as the main productive structure, regardless of the specific base – with Central and Southern Pame adopting '20' and '10' as their productive bases, while Northern Pame only uses '8'. Third, all three languages compose '4' by means of multiplication with the number '2' as the first term. In Central and Northern Pame '4' is formed by the semiproductive base Mr 2/(2) (*ki-ŋgui*, *ki-riui*), while in Southern Pame the second term of the word *ti-pijâ* remains opaque to analysis. Features that are shared by Central and Northern Pame include the structures [Mr 8 Add] and [Mr 10/(1/2)] to form semiproductive bases. Features

15. Perhaps the same is true for Southern Pame; but this is only a conjecture.

shared by Central and Southern Pame include the structures [$10^{\text{Mr } 2, 3}$ Add] and [Mr 20 Add].

4. Pamean number systems in typological and areal perspective

Culturally, archaeologically, and anthropologically, the Pame people are on the Mesoamerican border area (Kirchhoff 1943, Nalda 1990, Pailes & Whitecotton 1995, Reyman 1995). From a linguistic point of view, Pamean languages, as well as Chichimec, are outside the Mesoamerican area (Campbell, Kaufman, & Smith-Stark 1986), although unquestionably genetically affiliated to Otomanguean. I will argue that the diversity and patterning of Pamean number systems indicate that they blend typical Mesoamerican structures with unusual ones, unique to this group.

4.1. *Mesoamerican structures*

Mesoamerican languages typically present three major bases, '10', '15', and '20', exemplified by the languages in (17) (data from Barriga Puente 1998).

(17)		
	Comaltpec Zapotec	$10Mr^{3}$Add/15Ad/MMr^{5}20(+)Add
	Chocho	15Add/Mr20Add
	Cuitlatec	10^{Mr2}+Add/Mr20+Add
	Totonac	10Add/ Mr20+Add
	Yucatec Maya	10Add/ $Mr20^{2}$+Add

In fact, a base 20 has been considered as one of the five stable features defining Mesoamerica as a linguistic area:

> A counting system based on twenty is pan-Mesoamerican. While it is found in virtually every MA [Mesoamerican] language, it has also reached a few languages just beyond the conventional borders of MA … We may conclude that this is also a true MA areal trait which was sufficiently strong to reach slightly beyond the conventional boundaries. (Campbell, Kaufman, & Smith-Stark 1986: 546)

Pamean illustrates this claim nicely. It was shown in Sections 3.3.3 and 3.3.4 that bases 10 and 20 are fully productive in Central Pame, in harmony with the major Mesoamerican patterns. In contrast, we have seen that such bases are unattested in Northern Pame. The pertinent observation is that Central Pame is geographically closer to Mesoamerica than is Northern Pame – which would suggest a direct influence of Mesoamerican systems on counting in Central Pame. This hypothesis is reinforced by Southern Pame, an extinct language even more embedded in Mesoamerica, which presents the pattern 5 +Add/10^{Mr2}+Add/Mr20+Add, where, again, bases 10 and 20 are conspicuous. Therefore, on such evidence, I propose that bases 10 and 20 constitute a

Mesoamerican trait present in Pamean. By this hypothesis, because both Central Pame and Southern Pame display traces of base 8, while there is no evidence of Mesoamerican structures in Northern Pame, it is likely that Northern Pame represents the northern limit of Mesoamerica as a linguistic area. That is, I consider a numeral base 8 as the idiosyncratic common denominator for Pamean languages, and the bases 10 and 20 as a product of Mesoamerican affiliation.

4.2. *Non-Mesoamerican structures*

I have shown that the structure [(5) + Add] is present in both Central Pame and Northern Pame.[16] However, looking at the languages of the Americas in general, it turns out that this structure cannot be associated with a unique family or area. According to Barriga Puente (1998) this type is attested in a broad number of different families, namely, Uto-Aztecan, Eskimo-Aleut, Mixe-Zoquean, Algic, and Athabaskan.[17] Given this wide and random distribution, it would be difficult to claim that this feature associates Pame with a specific area or family. Thus, even though the structure [5 + Addend] is attested in Mesoamerica, the elided base 5 is not a common feature in the area (although it is not absent, as shown by Mixe-Zoquean). Therefore, possible influence from southern languages is implausible. Likewise, that some other instances of the feature are found in the north does not constitute evidence of diffusion by itself.[18] Hence, I suggest that the presence of base 5 in Central and Northern Pame in contrast with its absence in Mesoamerican languages should be considered another feature delineating the border of this major area. This is in line with a criterion proposed by Smith-Stark: "I have explicitly incorporated the notion of boundary by requiring that a language bordering the area not exhibit the areal features" (1994: 23).

Nevertheless, it is also possible that languages in border areas are characterized by a mixture of features belonging to distinct areas.

Base 8 is an uncommon feature across languages (Closs 1986, Greenberg 1978). In fact, there is no other system which exploits base 8 as extensively

16. Bernard Comrie points out that while multiplying by base 5 may be rare or absent in Mesoamerica, adding to products of 5 seems quite common; e.g., Classical Nahuatl had separate words for '5', '10', '15', and expressed for example '6' as '5 + 1', '11' as '10 + 1', '16' as '15 + 1', etc.
17. See Appendix 1 for a complete list of the languages of Mexico and North America displaying this feature.
18. The overt expression of base 5 is more widely attested. Perhaps this quite diverse distribution of base 5, both elided and overt, could be connected with a somatic motivation, namely the association with the word for 'hand'.

and productively as Northern Pame does, with the possible exception of Yuki.[19] Nevertheless, the data is so meager that the productivity of the two systems cannot be compared. However, there is no known relationship between Pame and Yuki languages.[20]

5. Conclusions

In this article I have proposed a formal characterization of Pamean number systems. This has allowed us to observe the typologically unusual base 8, which in Northern Pame is the only fully productive base. Pamean number systems also use bases 10 and 20, characteristic for Mesoamerica. I have suggested that this amalgam of bases is a consequence of the pivotal position of Pamean at the boundary of Mesoamerica and languages of north Mexico. Campbell, Kaufman, & Smith-Stark have called attention to the great importance of marked traits as criteria for linguistic areas: "highly 'marked', exotic, or unique shared traits weigh more than does material that is more easily developed independently, or found in other languages" (1986: 535).[21] To the extent that number systems are a structural feature that is easily diffused as a result of close contact among languages, the evidence provided by Pamean could contribute to our

19. The Round Valley Yuki system is (+) Add8/MrAdd16+ (data from Closs 1986, *apud* Barriga Puente 1998). The numbers include: 1 *pa-wi*, 2 *op-i*, 3 *molm-i*, 4 *o-mahat ~ op-mahat*, 5 *hui-ko*, 6 *mikas-tcil-ki*, 7 *mikas-ko*, 8 *paum-pat*, 9 *hutcam-pawi-pan*, 10 *hutcam-opi-sul*, 11 *momil-sul*, 12 *o-mahat-sul*, 13 *huijo-sul*, 14 *mikstcilki-sul*, 15 *mikasko-sul*, 16 *huico(t)*, 17 *pawi-hui-luk*, 18 *opi-hui-luk*, 19 *molmi-hui-poi*, 20 *omahat-hui-poi*, 64 *omahat-tc-am-op*. A reviewer notes that data from other Yuki languages might reflect diverse systems as different words were recorded for many of the higher numbers. Another reviewer mentions that some Pomoan languages might also have used a base 8, although this system seems to have been restricted to counting certain kinds of objects.

20. The other relationship of Pamean languages with languages from northern Mesoamerica, though unlikely, is with Coahuiltecan, an extinct language of doubtful affiliation spoken in the northwest of Mexico. As we showed earlier, the base 8 in Pamean is motivated by the counting of knuckles of the closed fist, i.e., 'four' for each hand, if the thumb is excluded. Interestingly, Coahuiltecan has a system with base 4 where, indeed, '8' is expressed as $4x2$, *puwäntz'an axtê*. This raises the possibility of a relation between the Coahuiltecan system and the base 8 system in Pamean. Nevertheless, a Pame-Coahuiltecan relationship must remain a conjecture at this point. I reproduce the Coahuiltecan numerals below (4, 5, 6, 20Mr+Add; according to Swanton 1940, *apud* Barriga Puente 1998): 1 *pil'*, 2 *axtê*, 3 *axtikipîl'*, 4 *puwãntz'an*, 5 *xûyopamãux ~ mãxauaxuyo*, 6 *tcikuãs ~ axtikpîl' axtê*, 7 *puwãntz'an ko axtikpîl'*, 8 *puwãntz'an axtê*, 9 *puwãntz'an ko xûyopamãux*, 10 *xûyopamãux axtê*, 11 *xûyopamãux axtê ko pîl'*, 12 *puwãntz'an axtikipîl'*, 13 *puwãntz'an axtikipîl' ko pîl'*, 14 *puwãntz'an axtikipîl' ko axtê*, 15 *xûyopamãux axtikipîl'*, 16 *xûyopamãux axtikipîl' ko pîl'*, 17 *xûyopamãux axtikipîl' ko axtê*, 18 *tcikuãs axtikipîl'*, 19 *cikuãs axtikipîl' ko pîl'*, 20 *taiwakõ*, 21 *taiwakõ ko pîl'*, 30 *taiwakõ ko xûyopamãux axtê*, 40 *taiwakõ axtê*, 50 *taiwakõ axtê ko xûyopamãux axtê*.

21. Indeed, a base 8 is not a linguistic universal, nor is it due to genetic relations, and it seems unlikely to be an independent, parallel chance development.

understanding of historical relations between the north-east of Mesoamerica and northern areas.

Ancient relations between Mesoamerica and the area immediately south of the United States border have been profusely documented for the western corridor on linguistic, archaeological, and ethnohistorical grounds. Likewise, there are indications that Mesoamerican borders have expanded considerably along the Gulf Coast (Smith-Stark 1994). Nevertheless, knowledge about remote contacts among the languages in the Southeast mainland is scarce. The linguistic evidence presented in this paper supporting the northern border of Mesoamerica should stimulate further research in linguistics, as well as in archaeology and anthropology, to test the hypothesis suggested here.[22]

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Abbreviations: Add addend, CONNECT connective, Mr multiplier, PL plural.

Appendix 1. Languages of Mexico and North America with base 5 elided (from Barriga Puente 1998)

Cora	(5)+Add/10^{Mr3}
Huichol	(5) +Add/10+Add/Mr20+Add
Havasupai	(5)Add+/10MrAdd+
Tonto	(5)Add+/10MrAdd

22. In this respect it is not insignificant that there are several cultural connections between Pame and Chichimec people with groups on the West Coast, mainly with Uto-Aztecans (Huichol, Cora, Tepehuan, and Tarahumara), as attested by similar dance patterns, the ingestion of psychotropics, and an annual Huichol pilgrimage to the Pame area. These may well constitute non-linguistic evidence as required by Sherzer (1973) in his definition of linguistic area.

Diegueño	(5)+Add/(10)Mr+Add(+)
Kiliwa	(5)Add+/10(x)Mr^{10} MAdd+
Klamath	(5)Add/Mr10+Add
Siuslaw	(5)Add+/Mr^{10}10x+Add
Unalit	(5)Add+/(10,15)Add/Mr(20)Add+
Inuktituk	(5)Add+/Mr10Add
Greenlandic Eskimo	(5, 10, 15+)Add/20MrxAdd->
Fox	(5)Add+/$Mr10^{2,3}$ Add (+)
Ojibwa	(5)Add+/Mr(x)10^2+Add
Montagnaise	(5)Add+/$Mr10^{2,3}$+Add
Cheyenne	(5)Add+//$Mr10^2$+Add
Delaware	(5)Add+/$Mr10^{2,3}$+Add
Natick	(5)Add+/Mrx$(10)^{2,3}$+Add
Arapaho	(5)Add+/Mr$(10)^2$Add+
Muskhog	(5)Add+/$Mr10^{2,3}$MrxAdd+
Tawasa	(5)(+)Add/10MrAdd(+)
Atsugewi	(5)Add+/Mr(10)Add+
Washo	(5)Add+/MMr^{10}10+Add
Sinkyone-Nongatl	(5)+Add/Mrx10^2+Add
Kato	(5)+Add/Mrx10+Add/15+Add
Popoloca	Add(5)/10Add/Mr20(+)Add
Totontepec Mixe	(5)Add+/10Add/MM$r20^5$(+)Add
Sayula Popoluca	(5)Add+/$Mr_5$$10^{Mr2}$+Add/$Mr^2$20(+)Add
Popoluca de Texistepec	(5)Add+/10^{Mr2}+Add/Mr20Add
Chimalapa Zoque	(5)Add+/10+Add/MMr^{20}20+Add
Copainala Zoque	(5)Add+/10Add/15+Add/MM$r20^2$+Add

References

Avelino, Heriberto (1997). Fonología y morfofonología del Pame norte. Tesis de licenciatura. E.N.A.H., INAH-SEP, México.

Barriga Puente, Francisco (1998*). Los Sistemas de numeración Indoamericanos: Un enfoque areotipológico.* (Colección Lingüística Indígena, 7.) México: Universidad Nacional Autónoma de México.

Bartholomew, Doris (1963). Pame dialectology. Unpublished manuscript.

— (1969). Los numerales del uno al diez en los Idiomas Otopameos. In *El simposio de México*: *Actas Informes y Comunicaciones*, *Programa Interamericano de Lingüística y Enseñanza de Idiomas*. México: Universidad Nacional Autónoma de México.

Campbell, Lyle (1979). Middle American languages. In Lyle Campbell & Marianne Mithun (eds.), *The Languages of Native America: Historical and Comparative Assessment*, 902–1000. Austin: University of Texas Press.

Campbell, Lyle, Terrence Kaufman, & Thomas C. Smith-Stark (1986). Mesoamerica as a linguistic area. *Language* 62: 530–570.

Closs, Michael P. (ed.) (1986). *Native American Mathematics*. Austin: University of Texas Press.

Di Peso, Charles C., John B. Rinaldo, & Gloria J. Fenner (1974). *Casas Grandes: A Fallen Trading Center of the Gran Chichimeca*. Dragoon, Arizona: Amerind Foundation.

Greenberg, Joseph H. (1978). Generalizations about numeral systems. In Joseph H. Greenberg (ed.), *Universals of Human Language*, Volume 3: *Word Structure*, 249–297. Stanford: Stanford University Press.

Instituto Nacional de Estadística, Geografía e Informática (2002). *XI censo general de población y vivienda, 2000*. Aguascalientes, México: INEGI.

Kelly, J. Charles (1966). Mesoamerica and the Southwestern United States. In G. F. Ekholm & G. R. Willey (eds.), *Handbook of Middle American Indians*, Vol. 4. Austin: University of Texas Press.

Kirchhoff, Paul (1943). Mesoamérica, sus límites geográficos, composición étnica y caracteres culturales. *Acta Americana* 1: 92–107.

Manrique Castañeda, Leonardo (1967). Jiliapan Pame. In Norman McQuown (ed.), *Handbook of Middle American Indians*, Volume 5, 331–348. Austin: University of Texas Press.

Nalda, Enrique (1990). Qué es lo que define Mesoamérica. In *La validez teórica del concepto Mesoamérica: XIX Mesa Redonda de la Sociedad Mexicana de Antropología. Colección Científica*. México: INAH, Sociedad Mexicana de Antropología.

Pailes, R. A. & Joseph W. Whitecotton (1995). The frontiers of Mesoamerica: Northern and Southern. In Reyman (ed.), 13–45.

Reyman, Jonathan E. (ed.) (1995). *The Gran Chichimeca: Essays on the Archaeology and Ethnohistory of Northern Mesoamerica*. Avebury: Worldwide Archaeology Series.

Sherzer, Joel (1973). Areal linguistics in North America. In Thomas A. Sebeok (ed.), *Current Trends in Linguistics*, Volume 10: *Linguistics in North America*, 749–795. The Hague: Mouton.

Smith-Stark, Thomas C. (1994). Mesoamerican calques. In Carolyn J. MacKay & Verónica Vázquez (eds.), *Investigaciones lingüísticas en Mesoamerica: Estudios sobre lenguas americanas* 1, 15–50. México: Instituto de Investigaciones Filológicas, Seminario de Lenguas Indígenas, UNAM.

Soustelle, Jaques (1937 [1993]). *La famille Otomí-Pame du Mexique Central*. Paris: Institute D'Ethnologie. [Spanish translation: *La Familia Otomí-Pame del México Central*. México: Centro de Estudios Mexicanos y Centroamericanos, Fondo de Cultura Económica.]