Two *pus* one makes thirteen: Senary numerals in the Morehead-Maro region

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Abstract

Southern New Guinea languages possess unusual senary systems, used for yam-counting. This article demonstrates the common presence of cognate base-6 numeral systems with monomorphemic power terms up to 6^6, with attestation across the major branches of the Morehead-Upper Maro group. Kanum, related to the Morehead-Upper Maro family, has cognate forms but with ambiguity between the readings 6n and 'numeral in nth senary cycle', while Agöb in the neighbouring Pahoturi family has recently borrowed the senary power numerals. Evidence is presented for convergent cultural factors that would have selected for the emergence of a base-6 numeral system, including the six-petal arrangement in which they are laid out in piles and other aspects of ceremonial counting routines.

Keywords: *linguistic area, New Guinea, number systems, numeral base, numerals*

> the all-important tubers are first counted by astonishingly sound arithmetic, and then stored in the darkness of the long low houses
> (Williams 1936: 17)

1. Introduction

Mark Donohue's recent note on senary numerals in this journal (2008), plus the response to it by Harald Hammarström in this issue, raise intriguing questions about the structure, typological rarity, and possible broader historical significance of senary numeral systems in Southern New Guinea. In this brief note I would like to extend their discussion of this unusual numeral system by adding some new descriptive and comparative data from the same region.

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In Section 2 I briefly review the extant evidence for the genetic coherence of the Morehead and Upper Maro languages, plus Kanum. In Section 3 I give new empirical data from Nen, the easternmost language of the Morehead-Maro region, which like Kanum has a set of monomorphemic bases for ascending powers of six, but which differs from Kanum in assigning unambiguous numerical values to them. In Section 4 I consider further comparative data suggesting that a single historically-relatable senary system is found across most of the Morehead-Maro region, and that all languages except Kanum resemble Nen in having unambiguous power-of-six readings. In Section 5 I consider a puzzle not explained in Donohue's note, namely the semantic motivation for the relationship between the two sets of readings for the cognate numerals in Kanum. In Section 6 I take up Hammarström's argument that the emergence of senary systems in South New Guinea is linked to the counting of yams, and give further cultural details as to why this practice should favour six rather than some other number, at least in the Southern New Guinea context. I conclude in Section 7 by articulating the possible role of parallel cultural patterns as a selector on the emergence of convergent linguistic systems, and state a number of alternative explanatory hypotheses regarding the history of South New Guinea senarism that call for further research.

2. The Morehead-Maro languages as a genetic unit

The languages of the Morehead-Upper Maro group span the Papua New Guinea/Indonesian border in Southern New Guinea. Around twenty languages are clustered into a region running about 200 km from west to east, and 150 km from south to north. Earlier lumping classifications by Wurm (1975) and Wurm & Hattori (1981) placed them within the larger "Trans-Fly Stock", along with the Pahoturi Rivers languages group (Idi, Ende, and Agöb) and the languages of the Eastern Trans-Fly (Gizra, Gidra, Bine, and Meryam),[1] as well as further postulating a relation to the Yelmek-Maklew languages south of the mouth of the Digul river. A more cautious recent proposal by Ross (2005) breaks the Eastern Trans-Fly languages away from this stock, but still places the Morehead-Maro languages together with the Pahoturi Rivers languages and Yelmek-Maklew in a tentative "South-Central Papuan group". There is a further language, Moraori, in the south-western corner of the Morehead, which Ross (2005: 35) suggests is a family-level isolate within the Trans-New Guinea phylum.

My own view is that all of the above classifications understate the degree of linguistic diversity in the South New Guinea region, and that Morehead-Maro, Pahoturi Rivers, and Eastern Trans-Fly are separate families, with Moraori an

1. Wurm (1975) also included Tabo/Waia.

additional isolate. This is in addition to a number of other (relatively) better-known families of Southern New Guinea, including Marind and its relatives, Kiwai, Suki, and Gogodala to the north (which are possibly Trans-New Guinea though this is not proven), and the languages of the Western Torres Strait Group (Kala Kawaw Ya, etc.) on the islands just to the south, which belong to the Pama-Nyungan family of Australian languages (Evans 2005).

However, any assessment of relatedness is made difficult by the paucity of available materials. For not one language of the putative Morehead-Maro Rivers family do we have a modern published grammar or dictionary[2] – not even a sketch. The same goes for Moraori, and for the entire Pahoturi Rivers family. It goes without saying that until such materials are available it would be premature to assess the relations between these languages.

Within the Morehead-Upper Maro River family (henceforth Morehead-Maro for brevity), Gordon (ed.) 2005 (*Ethnologue*) presents a classification that divides it into three branches – Nambu (with around five closely related languages, depending on the criterion for language-hood), Tonda (with around ten languages, including Arammba), and Yei (further divided into either dialects or closely-related languages). It is also likely that Kanum (itself with half a dozen dialects) is related to this family, as a sister at a higher node of relatedness, as shown schematically in Figure 1, though this is not claimed by *Ethnologue*.

Shared vocabulary across the family (aside from the senary numerals being discussed here) is remarkably sparse – between Nen (the easternmost language) and Yei (the westernmost) it is difficult to find more than a handful of lexical cognates.

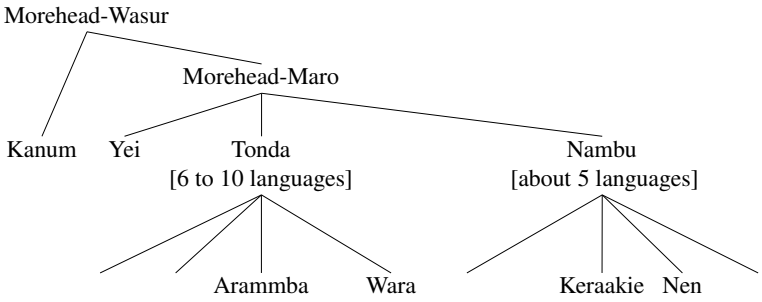

Figure 1. *A heuristic classification of the Morehead-Maro languages*

2. At present the best source on a language of this family is Boevé & Boevé 2003, still unpublished, while the best published sources are the short chapters on Moraori, Yei, and Kanum in Boelaars 1950 and Drabbe 1954.

Table 1. *Sample cells from paradigm of 'be, stay, dwell' in languages representing the three branches of Morehead-Maro, plus Kanum*

	Yei 'dwell'	Tonda branch: Arammba 'live, stay (restr.)'[a]	Nambu branch: Nen 'be'	Kanum 'be'
1SG	*wən wəm*	*wom*	*wɐm*	*wᴅ*
2SG	*wən nəm*	*nom*	*nɐm*	*nᴅ*
3SG	*wən yəm*	*δom* (MASC)	*yɐm*	*yᴅ* (MASC)
		wem (FEM)		*tᴅ* (FEM)
3PL	*wən yem*	*yom*	*yem*	*yᴅ*

a. Though imperfective forms adding *-nda* to this form are commoner: *womnda*, *nomnda*, etc.

However, there are revealing similarities in the bound pronominal paradigm, as shown in Table 1, that suggest some form of genetic connection. The partial paradigm of the verb 'to be, stay, dwell' given in Figure 1 suggests an original prefixal series *w-* '1SG', *n-* '2SG', *y-* or *δ-* '3SG' (with the existence or otherwise of gender unclear), and *ye-* '3PL' (noting the comparable vowel change in Yei and Nen in the 3rd person plural). Other examples of shared morphology include:

(i) the 'towards' verbal prefix *-(ɐ)n-* (Nen *-ɐn-*, as in *karamb!* 'go up' vs. *kɐnaramb!* 'come up'; Yei *kandrə* 'go up!' vs. *kɐnandrə* 'come up!'; Arammba *δayanda* 'he is going' vs. *δanyanda* 'he is coming');

(ii) the appearance of a *k-* prefix in 2nd person singular imperatives either in addition to or supplanting the basic 2SG prefix *n-*: Nen *k-* (again, *nɐngɐm*! 'you are going' vs. *kanɐngɐm*! 'you go!'), Yei *k-* (*kandrə* 'go up!'), Kanum *b-an* 'you/he/she/it go(es)' vs. *k-an-t*! 'you go!', and Arammba *ŋgǯn-* (*ŋgǯnomǯx!* 'you stay!', 2SG imperative *ŋgǯn-*).

The above data is heuristic only, but represents the sort of shared paradigmaticity that points to genetic relatedness (Nichols 1996) and which needs to be followed up by a proper application of the comparative method once more substantial materials on these languages are gathered. It is relevant to our understanding of the origins of the senary system because it suggests that the distribution of the senary numerals Hammarström mentions is coextensive with the Morehead-Maro family. Hammarström suggests the system has recently been diffused across this family, but another possibility is that they will prove to be reconstructable to proto-Morehead-Maro and hence be a system of some antiquity. I will return to this point below.

3. The Nen system

Nen (or Nen Zi)[3] is the easternmost language of the Nambu subgroup of the Morehead-Maro family. It is spoken in just one village, Bimadeben, by around three hundred people.[4] Like most languages in this family except Yei, it has a senary numeral system whose numbers above five have the following basic structure:

(1) $N_1\ S_x\ [(\text{conj})\ N_2\ S_{x-1}]^*\ [\ (\text{conj})\ N_3\ (\textit{káp})]$

where S_n denotes a monomorphemic numeral denoting a power of six, with n ranging from 1 to 5 (traditionally to 6). In other words, numerals are formed by concatenating multiples of power-of-six bases, in descending order, then following this with a final addend between one and five if necessary.[5]

Table 2 contains examples illustrating specific numerical values and how they are expressed in this system.[6]

As can be seen, the basic elements of the system are:

(i) numerals from one to five, namely *ambás*, *sombés*, *nambis*, *sombés a sombés*, and *widmátandás* ('four' is literally 'two and two', and five means 'back of hand')

(ii) a set of monomorphemic numerals for ascending powers of six:

pus	6	6^1
prta	36	6^2
taromba	216	6^3
damno	1,296	6^4
wèrèmaka	7,776	6^5

We shall see in Section 4 that some related languages have a further power term meaning 6^6, but this is not used by contemporary Nen speakers. One older

3. Within the Nambu branch of the Morehead-Maro River family, language names are mostly based on the word for 'what', which is what *nen* means. *Zi* means 'word, language', and in most contexts where a language name would be used in English (e.g., 'speak L', 'teach me L') the phrase *Nen zi* is used.

4. Nen data was recorded during a fieldtrip I made to Bimadeben village, Western District, Papua New Guinea, from 1 to 12 October 2008.

5. Once the numbers exceed twelve, any final addend is followed by *káp* 'only'. It is not yet clear how conventionalised the use of the conjunction *a* or *má* is before the addend.

6. I use the practical orthography in use in the Bimadeben elementary school. Most letters have their expected phonetic values, except that the five Latin vowel letters have to accommodate an eight-vowel system with three front, three back, and two short centralized vowels. *è* denotes the low front vowel /æ/, while *é* represents a brief high front lax vowel (roughly [ɪ]) and *á* is a central lax vowel between [ɒ] and [ə]; *z* varies between [ʤ] and [ʣ] and *r* can occupy nucleus as well as onset and codal positions.

Table 2. *Sample Nenzi numerals*

1	1	*ambás*	one
2	2	*sombés*	two
3	3	*nambis*	three
4	$2+2$	*sombés a sombés*	four
5	5	*widmátandás* ('side of the hand')	five
6	1×6	*ambás pus*	one *pus*
7	$1\times6+1$	*ambás pus ambás*	one *pus* one
8	$1\times6+2$	*ambás pus sombés*	one *pus* two
12	2×6	*sombés pus*	two *pus*
13	$2\times6+1$	*sombés pus ambás káp*	two *pus* one only
14	$2\times6+2$	*sombés pus má sombés*	two *pus* and two
15	$2\times6+3$	*sombés pus a nambis káp*	two *pus* and three only
18	3×6	*nambis pus*	three *pus*
19	$3\times6+1$	*nambis pus ambás káp*	three *pus* one only
30	5×6	*widmátandás pus*	five *pus*
31	$5\times6+1$	*widmátandás pus ambás káp*	five *pus* one only
36	1×6^2	*ambás prta*	one *prta*
37	$1\times6^2+1$	*ambás prta ambás káp*	one *prta* one only
45	$1\times6^2+1\times6+3$	*ambás prta ambás pus na nambis káp*	one *prta* one *pus* and three only
216	1×6^3	*ambás taromba*	one *taromba*
1,296	1×6^4	*ambás damno*	one *damno*
7,776	1×6^5	*ambás wèrèmaka*	one *wèrèmaka*
46,656	1×6^6	*(wèrèmaka tenz)*	

speaker, Aramang, mentioned a further term *wèrèmaka tenz*[7] which he thought might be a higher member of the series, but I was not able to determine its value precisely.

Multiples of the power terms are formed by placing one of the basic numbers directly in front of a power-of-six term. It seems that even single multiples of the senary power-of-six terms must be expressed overtly using *ambás* 'one'. Examples: *ambás pus* 'six', *sombés pus* 'twelve', *nambis pus* 'eighteen', *ambás prta* 'thirty-six, i.e., one *prta*', *ambás prta ambás pus na nambis káp* 'forty-five, i.e., one *prta* plus one *pus* and three only'.

As in other languages of the region, the higher powers of these numbers are only used in counting yams. For counting other objects whose number exceeds

7. Aramang stated that he doesn't use this one himself, but remembered his parents using it. He also stated that there is a further term *meme wemb*, meaning 'beyond counting, infinity'; this is cognate with the Keraakie term *meemee wemb* '6^7' though there is a difference in meaning that warrants further investigation.

six, expressions like the following are used (i.e., 'two hands' for 'ten'), though further data on this is needed.

(2) *tande* *dene* *togetoge* *y-ángám,* *widmatánd* *a*
1SG.POSS thus children 3SG.U-go side.of.hand and
widmatánd.
side.of.hand
'I have ten children (showing hands with extended fingers).'

4. Similarity of the power numerals through the Morehead-Maro family

Most languages of the Morehead-Maro family, except Yei,[8] appear to have systems comparable to Nen, and the power-of-six numbers are cognate with the senary-exponential values of the Kanum terms. At least one unrelated language just to the east of the Morehead-Maro family, namely Agöb, also has related terms.[9]

Table 3 sets out four such systems: two from the Nambu branch (Nen and Keraakie[10]), one from the Tonda branch (Arammba) and the exponential-series terms from Kanum. It will be seen that the Keraakie system goes up to the seventh power of six (*fide* Martin), the Arammba to the sixth, and the Nen and Kanum to the fifth.

It is clear that all of these terms, except the number for six itself, are formally related, though at this stage we lack any understanding of the regular sound correspondences in the family that would either allow us to reconstruct the original forms, or distinguish borrowed from inherited vocabulary.

As the right hand side of the table shows, a related system is found in at least one language of the adjoining Pahoturi River family, Agöb, in the variety spoken within the village of Buzi. Since the Pahoturi River family appears unrelated to the Morehead-Maro family, this is evidence that at least some other

8. Hammarström's statement that Yei lacks a senary system tallies with by my own brief recordings from Yei speakers in two villages, Po and Erambu, up the Maro River on the Indonesian side of the border: neither dialect appears to have numerals above three.
9. As recorded in the village of Buzi by Kevin Murphy (personal communication); it is not currently known whether other Agöb varieties also have this system. Interestingly, multiples (as opposed to powers) of six are formed by using a multiplicand from the (etymologically unrelated) Agöb numeral set, e.g., *kumuLi put* '12' (*kumlibi* 'two') *kumledga put* '18' (*kumledga* '3'), and *kumkumlong put* '24' (*kumkumlong* '4'). (The /l/ phoneme is realised as l by some speakers and r by others; it seems likely to Kevin Murphy, who recorded these terms, that there is no phonemic difference between these in the language. A poster hanging in the elementary school transcribed them as *kumlibi*, *kumledga*, and *kumkumlong*. It is not yet clear whether the r in the power numerals is an exception to this realisational freedom, as would befit a loan phoneme.)
10. Williams (1936) spells this Keraki and Martin (2001) as Keraakie; this variety is also referred to as Nambo.

Table 3. *Senary-power numerals in Nen, with corresponding forms from Arammba (from Boevé & Boevé 2003), Keraakie (Martin 2001: 85, with figures from Williams 1936: 226–227 in square brackets if known), Kanum (Donohue 2008), and Agöb (Kevin Murphy, personal communication) for comparison.*

Value	Power	Nen (base)	Keraakie	Arammba	Kanum exponential term	Agöb (Buzi village)
6	6^1	*pus*	*(eembru) for*	*nimbo*		*put*
36	6^2	*prta*	*ferta (eembru)* [*peta*]	*feté*	*ptae*	*purta*
216	6^3	*taromba*	*taromba* [*tarumba*]	*tarumba*	*tarwmpao*	*tarumba*
1,296	6^4	*damno*	*daameno* [*dameno*]	*ndamno*	*ntamnao*	*damuno*
7,776	6^5	*wèrèmaka*	*werameka*	*wermeke*	*wrmaekr*	*waramakai*
46,656	6^6	[]	*wi*	*wi*		
279,936	6^7		*meemee wemb*			

South New Guinea languages have adopted the system as a result of diffusion, and in fact people in the village state that this system has been borrowed from the west.

5. Rationalising the dual values of Kanum numerals

So far, Kanum is the only language of the area reported for which numbers in the set given in Table 3 have two sets of values. The values cognate with those elsewhere are the senary-exponential ones. Although Donohue's article carefully lists these two sets of values, he does not discuss the systematic relationship between them, which I now discuss briefly. Table 4 represents the two sets of numerical values for these Kanum bases.

As Table 4 makes clear, there is a systematic relation between the two values: a number whose exponential value is 6^p will have a "lower" value of $6(p-1)$. The downward slippage showing up as the "-1" in this formulation can be eliminated if we remember that the first cyclical count begins by adding to zero, so that the second cyclical count adds to one times the multiplier, the third count adds to two times the multiplier, and so on. In other words, a higher number is ambiguous between a value in which it is the nth power of 6, or the nth count through a six-valued cycle.[11]

11. The attentive reader will note that these structures only take us as far as 29 $(4 \times 6 + 5)$. Extrapolating from the data given so far, we would expect the numbers from 30 to 35 to be

Table 4. *Exponential and cyclical values of semantically unambiguous Kanum numerals*

	Exponential value	Cyclical value	Example	Generalisation
ptae	6^2	6; $n_{\langle 1\ldots5\rangle} + 6$	*ylla ptae* 9, lit. three *ptae*, i.e., 3+ *ptae*; *eser ptae* 10, lit. four *ptae*, i.e., 4 + *ptae*	2nd count through cycle of six
tarwmpao	6^3	12; $n_{\langle 1\ldots5\rangle} + 12$	*ylla tarwmpao* 15, lit. three *tarwmpao*, i.e., 3 + *tarwmpao*; *eser tarwmpao* 16, i.e., 4 + *tarwmpao*	3rd count through cycle of six
ntamnao	6^4	18; $n_{\langle 1\ldots5\rangle} + 18$	*aempy ntamnao* 19, i.e., 1 + *ntamnao*	4th count through cycle of six
wramaekr	6^5	24; $n_{\langle 1\ldots5\rangle} + 18$	*aempy wramaekr* 25, i.e., 1 + *wramaekr*	5th count through cycle of six

This fascinating ambiguity in the numerical values of these terms merits further study. Donohue's data are predominantly drawn from the Yanggandur dialect, and it remains to be seen whether all dialects of Kanum exhibit the two readings, and whether dialectological evidence points to an ancestral dual-value system for pre-Kanum, or a single-value system of either the cyclical or exponential types. It would also be good to obtain ethnographic material showing how people actually carry out the counting routines, along the lines of that cited from Williams 1936 in the next section.

Extended data of this type will in turn affect our view of whether a senary exponential system should be reconstructed for proto-Morehead-Wasur. One possible scenario, for example, would be that proto-Morehead-Wasur had a set of numerals formally relatable to those in Table 3, but with cyclical values. Proto-Morehead-Maro would then have reanalysed these as having exponential values, and that this additional layer of meanings was then borrowed back into Kanum.

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formed from a monomorphemic base that could mean either 6^6 or 30. However, in Donohue's data no number comparable to Arammba *wi* or Keraakie *wiwi* (both 6^6) is mentioned, nor any corresponding monomorphemic base for 30. Instead, 30 is expressed additively as *ptae wramaekr* [6(+)24] and the numbers 31 to 35 by further additions to this, e.g., 31 as *aempy ptae wramaekr* [1(+)6(+)24].

6. The Morehead-Upper Maro senary system and yam-counting

In all languages of the family, the use of the senary system is intimately associated with the counting of yams, as already observed by Williams (1936) and Lean (1986). This suggests that the question of whether the system is inherited or diffused may be of wider importance in determining the antiquity of yam-growing as the staple economy in Southern New Guinea. It is interesting that Yei, the one Morehead-Maro language lacking a system of senary exponents, is located in wetter country where the burning off of swiddens necessary to yam cultivation is not possible. For the Yei-nan, it is sago rather than yams that is the staple, rendering a senary counting system functionally unnecessary.

I therefore believe that Hammarström (2009) is correct when he seeks to ground the emergence of a senary system in this family with the counting of yams, and with the development of a tuber-cultivating economy which requires the storage of determinate numbers of yams from one year to the next. Indeed, Williams (1936: 227) states for the Keraki that "it is apparently the aim of a conscientious gardener to store at least a *dameno* of sizeable *taitu* [small yams – NE]". This emphasises the role of the fourth senary power as a yardstick of appropriate foresight and provisioning.

However, Hammarström's statement that "there is nothing we know about yams that predicts 6 – it could have been 4, 7, or some number" requires some comment and modulation. Certainly it does not follow automatically that yam-counting will promote the emergence of a senary system, since tuber-based cultures across New Guinea have generated an enormous variety of counting systems. However, if we look more closely at how yams are counted (and this may in part depend on the typical shape of yams grown in the area – a question that has yet to be investigated), we can identify at least two factors that would select in favour of a base-6 system.

Before doing that, however, a brief comment on bodily counting routines is in order. Though hands have five fingers, making five seem a natural base to many cultures of the world, an alternative way of viewing them is that they have six attachments – five fingers plus the wrist/arm that leaves the palm in the opposite direction. When Nen speakers count, they first count off the five fingers with a finger of their other hand, and then on the sixth they place their counting finger on the inside of the wrist. In other words, the relevant bodily cycle is fingers + wrist, i.e., the six protrusions from the palm of the hand. This is similar to the method Donohue describes for Kanum, except that in Kanum the wrist is grasped on the sixth count, rather than touched with the finger as in Nen. This method shows that, if you speak a senary language, mapping base six onto the body is not difficult to do. However, I would not want to argue that the "six attachment" conceptualisation of the hand is one that naturally occurs to humans in a culture-independent way,

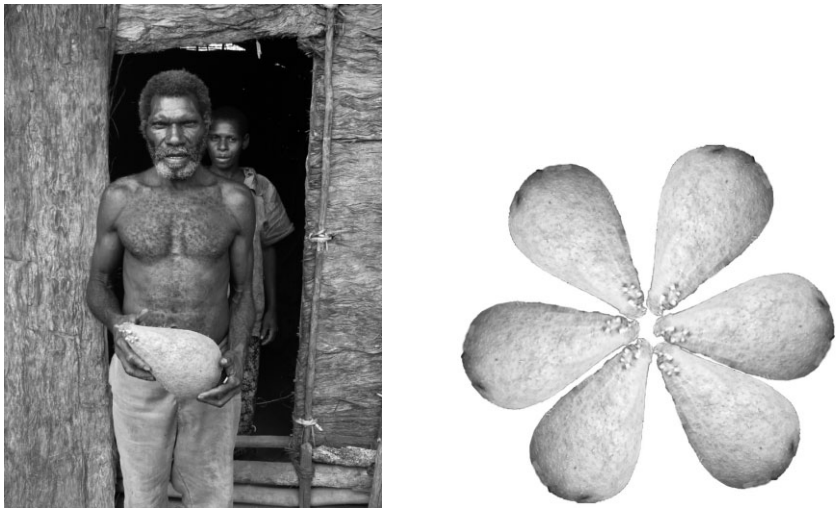

Figure 2. *Left: Nen speaker Kámongo Bálába standing in the door of his* sarángw *(yam storehouse) with a* náne *(yam). Right: Montage illustrating six-petalled arrangement in which yams are laid out during ceremonial counting.*

since we would then face the problem of explaining why senary systems are so rare.

Passing now to the cultural particularities of South New Guinea yam-counting routines, there are two facts about them which point to the naturalness of six as a base.

First is the way yams are laid out in piles. Villagers in Bimadeben who showed me the way yams are laid out for counting arranged them so as to radiate from their points, placed together centrally, at 60 degree angles (as illustrated in Figure 2). For the yams they were arranging, this arrangement sits well physically, suggesting that the particular thickness of the typical yams grown in this area makes this layout a natural one.

Secondly, in the ceremonial counting of yams, units were laid down by two men at a time, each holding three, as indicated in the following description made by the Papuan Government Anthropologist Williams in the 1930s for the Keraakie people:

> [. . .] two men begin to tell them over. Each picks up three at a time, and they move off a few paces, and deposit them together. Meanwhile one of them, who acts throughout as teller, is shouting *Nyambi, nyambi, nyambi,* . . . (i.e. 'One, one, one. . . '). This means that they have put down the first unit of six. Without pausing they again take three each and as soon as these are deposited the teller changes

> his should to *Yenta, yenta, yenta*, ... (i.e. 'Two, two, two, ...'). So they proceed until six units of six have been deposited, when the teller throws one of his last handful to a third man sitting by, who places it before him as a counter to show that thirty-six taitu, or one *peta*, have been set down. The two men, however, do not pause, but count another six sixes, depositing them on top of the first *peta*; and, as they complete this second *peta*, the man who sits by silently places the second counter. So they go on until they have finished six *peta*, when they pause and the counters are carefully told over to verify. Five of these are thrown on to the heap, while one is kept as a major counter. By now there is a heap of $6 \times 36 = 216$ (less the one kept as a major counter) and this heap constitutes one storage heap called *tarumba*.

The practice of laying the yams down by pairs of men will generate an even-numbered base. Why they should grasp three each rather than two, four, or five is a separate question but the yams are substantial in size and cumbersome to hold in large numbers so three does not seem an unnatural choice. Once made, and coupled with the use of pairs of men to place the groups of three together, six falls out as a natural choice. And the counting algorithm described so carefully by Williams indicates that the extension of six as an exponential base also follows naturally from the way the third teller uses counter yams to tally the number of piles.

7. Cultural context as a selector for lexical structure

My point in giving the above ethnographic details is to sketch the way particular cultural practices might act as selective agents for the emergence of particular numerical systems.[12]

In considering the crosslinguistically unusual clustering of senary number systems in Southern New Guinea, we have three possible hypotheses:

(i) INHERITANCE, i.e., that the common presence of senary numeral systems is a shared inheritance from an ancestral system. For the Morehead-Maro Rivers family at least, this would square with a scenario in which the use of senary numerals for yam-counting goes back to proto-Morehead-Maro Rivers (plus or minus Kanum), and in which the expansion of this language family in Southern New Guinea was a case of demic diffusion intimately connected with yam-growing and yam-storage.

12. For anthropological treatments that relate the shape of particular number systems to their social and cultural contexts, see Mimica 1988, Urton 1997, and Keen (in preparation). And see Evans 2003 for a model of how common cultural emphases can funnel the convergent development of linguistic structure, and the papers in Enfield (ed.) 2002 for further case studies on the impact of culture on language structure.

(ii) LINGUISTIC DIFFUSION. On this model, the senary numerals were borrowed directly across languages of Southern New Guinea, much as the Chinese numeral system diffused into Korean and Japanese. The cultures that accepted it may already have been based on tuber-cultivation, or adopted it more recently, but in either case took over borrowed numerals for counting larger numbers.

In fact, the linguistic diffusion model can be separated into two types, parallelling the familiar distinction between direct borrowing and calquing/metatypy. In addition to the direct model, it is possible that languages borrow the conceptual system through bilingualism but come up with their own, independent forms. This does not appear to be an appropriate model for the Nambu languages, since the forms are so obviously relatable, but could be appropriate as a model for the extension of senary numerals into the Kolopom languages, whose forms are not readily relatable to those of the Morehead-Maro group.

(iii) CONVERGENT CULTURAL SELECTION. This model does not require linguistic contact at all as an explanatory mechanism. Instead, it postulates convergence in the non-linguistic cultural practices that act as selectors on emergent language systems. Imagine a situation where ancestral Kolopom speakers employ counting practices comparable to those described above, which were shared with their neighbours as a result of non-linguistic convergence of cultural practice. Naming systems for particular points in the counting algorithm, such as the enumeration of piles of six, could then emerge independently of the terms used in the languages to their east. Indeed, they could have developed independently even after the erstwhile neighbours that had converged in their cultural practice had been separated by an intrusive group like the Marind.

We are not yet in a position to decide which of these hypotheses is correct, and of course more than one may apply to different stages of the historical scenario. It could be the case, for example, that the senary power numerals given in Table 2 were ancestral to the Tonda branch – possibly reflecting a Tonda-specific reanalysis of an older system of the Kanum type where the higher numerals are ambivalent between senary multiples and senary exponentials. This could then have been spread by direct diffusion through the rest of the Morehead-Maro Family. The formally unrelated numerals of the Kolopom system would have arisen either through indirect diffusion, or culturally-selected convergent development. Selecting between these scenarios will not be possible until we have much fuller data, both synchronic and diachronic, on the languages of this fascinating region.

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Abbreviations: 1/2/3 1st/2nd/3rd person; FEM feminine; MASC masculine; PL plural; SG singular; U Undergoer prefix (objects, plus subjects of some intransitive verbs).

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