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by
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KAUGEL VALLEY SYSTEMS OF RECKONING⁽¹⁾

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In common with other peoples of Papua New Guinea's Highlands districts, the Kakoli-speaking people of the Upper Kaugel Valley regularly deal in large quantities of valuable objects which demand efficient methods of counting. We describe here the formal, complex system used in ceremonial prestations and other, everyday systems used in reckoning common entities and relationships. We make some suggestions about the nature and development of Western and Southern Highlands counting systems.

In a recent survey of Papua New Guinea numeration techniques, Wolfers⁽²⁾ reports abstract and/or finger-counting systems with bases of 3, 4, 5, 6, 10, 20, and 60. A 24 based system such as that in use amongst upper Kaugel people does not appear to have been described previously. A further feature of Kaugel reckoning has not been reported before: one of the Kaugel ways of expressing parts, or fractions, is congruent with the system of numbering whole entities.

Most authors relate little about the actual context⁽³⁾ in which numeration techniques are used, the numbers usually being listed according to English or German glosses. Therefore the real nature of counting systems is obscured; for example, the formal count cannot be distinguished from the occasions when one simply ticks off entities on one's fingers. We list below, for reference, the "numbers" in Kakoli and in some related neighbouring languages: Melepa, Enga, and Kewa. We wish to stress, however, that although the observer can elicit such a list, there is no occasion in the upper Kaugel when one really uses the numbers as they are listed in Table 1. We go on to outline the contexts in which various Kaugel numeration systems are actually used.

1. We thank the following agencies for grants and fellowships that supported field work: The Social Science Research Council and the New Guinea Research Unit. An Auckland University Research Committee grant helped finance Mr Lepi's work in 1975. We are very grateful to Ralph Bulmer for his encouragement and for commenting on drafts of this paper. We alone are responsible for interpretations of the literature on Papua New Guinea numeration systems and for any possible errors in the Kaugel material.
2. Wolfers 1971.
3. Strauss and Tischner 1962:8 specifically state that the Kewa body count is used only at ceremonials for counting numerous valuables and pigs.

TABLE 1
Some Western and Southern Highlands Numerals⁽⁴⁾

English	Kakoli ⁽⁵⁾	Melepa ⁽⁶⁾
1	telu	dende ⁽⁷⁾
2	talu	rakl
3	yepoko	rakltika
4	kise	tembokaka or tembokaketle
5	te(lu)pakara	pombi (thumb) or pombiŋkutl
6	talupakara	pombiŋkutl dende or aŋelamb dende or ŋkutl rakl
7	yepokopakara	pombiŋkutl rakl or kotlrakltika
8	engaki	eŋkaka or eŋkakaketle ki dende (one hand)
9	rureponga telu	pombi ti ŋkutl
10	rureponga talu	pombinraklŋkutl
11	rureponga yepoko	pombinrakltikaŋkutl
12	rurepo	tembokakapokət
13	malapunga telu	tembokakapokət pombin ti ŋkutl
14	malapunga talu	tembokakapokət pombin rakl ŋkutl
15	malapunga yepoko	tembokakapokət pombin rakltika ŋkutl
16	malapu	ki rakl (two hands)
17	supunga telu	ki rakl tende ŋkutl
18	supunga talu	ki rakl rakl ŋkutl
19	supunga yepoko	ki rakl rakltika ŋkutl
20	supu	ki rakl tembokaka
21	tokapunga telu	ki rakl pombiŋkutl
22	tokapunga talu	ki rakl pombiŋkutl dende
23	tokapunga yepoko	ki rakl pombiŋkutl rakl
24	tokapu	ki rakltika (three hands)
25	alapunga telu	
26	alapunga talu	
27	alapunga yepoko	
28	alapu	
29	polangipunga telu	
30	polangipunga talu	
31	polangipunga yepoko	
32	polangipu	

4. Southern Highlands body-count systems can be found in Franklin and Franklin 1962; Franklin 1968; Strauss and Tischner 1962; and Williams 1940. They are difficult to list and compare, as each has a unique set of anatomical referents.

5. Kakoli is the main language of the upper Kaugel valley. Kakoli orthography used here generally follows Blowers 1970, with the following exceptions: we indicate all prenasalisation and some palatalisation as do Kakoli-speaking persons literate in English or Pidgin. Other differences from Blowers 1970 relate to dialects within the Kaugel.

Kakoli dominates in the upper Kaugel and the north-eastern section of upper Mendi. Our material is based on the language as it is spoken from Lakope ("Kagop" in Government records) to Puluwa and Kiripia along the north-western bank of the Kaugel river. The people themselves refer to their language as *umbu ūngu*—*ples tok* in Melanesian Pidgin or "native language" in English.

6. Melepa (Medlpa) numerals from Vicedom and Tischner 1948:(I)237-8.

7. The relations between the article and the numeral "one" in Western-Southern Highlands-Enga languages is beyond the competence of the authors. In Kakoli, *te* is the article which can be translated as "the, a, an" or "another" and it sometimes replaces *telu* "one" in certain contexts.

Kewa⁽⁸⁾

1	pameda
2	lapo
3	repo
4	ki
5	kode or kina kode (thumb; hand's thumb)
6	kode lapo or kina kode lapo
7	kode repo or kina kode repo
8	ki lapo (two hands)
9	ki lapona kode (pameda)
10	ki lapona kode lapo
11	ki lapona kode repo
12	ki repo
13	ki repona kode (pameda)
14	ki repona kode lapo
15	ki repona kode repo
16	ki mala (four hands)
17	ki malana kode (pameda)
18	ki malana kode lapo
19	ki malana kode repo
20	ki su

Enga⁽⁹⁾

	Crotty	Baiyer River	Lang
1	mend (ái)	međaki	mendái
2	rab(um)	lama	lápó; lapóma; lapóta
3	teb	rema	téma; tépó; tepóma
4	kirúmend	kisima	kitómende; kitúmende
5	juúŋk; juŋki	kigi páke	yángi púndu; yáu; yáunge; yuungí
6	t(r)ogaŋk	pakenarŋage (ŋage = "thumb")	tókange
7	karáŋk	yadaipigi	kálange; sekáita
8	tuguráb	ilyaŋpigi or akalisa mage lama	máŋge láo waketau; tukulápó
9	tuguríb	akalisa mage međaki	tukutépó
10	tuguréponja-méndai	akalisa or podo	akalítá mendái; máŋge pundu; tukutéponya mendái
11	tuguréponja-ráb		
12	tuguréponja-téb		
13	tuguréponja-gáro		
14	mabonjéménd(ai)		
15	mabonjéráb		
16	mabonjótéb		
17	mabonjégáro		
18	júbonjéménda		
19	júbonjéráb		
20	júbonjótéb		akalítá lápó

8. Kewa numerals from Franklin and Franklin 1962. See also Franklin 1968.

9. Enga dialects as follows: Crotty 1951; Lang 1973; Baptist New Guinea Mission Baiyer Valley.

FORMAL COUNTING

Kaugel kin groups (clans, segments of clans, and occasionally combinations of clans) formally distribute large numbers of goldlip pearlshells, pigs, game animals, and other valuables. There are two forms of pig distributions; in both, thousands of animals may change hands in a single day. Live pigs are formally presented to new owners at one and in the second type pigs are killed and the pork itself distributed to masses of visitors. In all these circumstances, the valuables are lined up in rows—in the case of forest game, animals are sorted into heaps of particular types—pigs, however, are tied to stakes in long rows, sometimes half a mile or more long. The objects have usually been acquired through intermediate donors, to whom obligations are incurred. In addition to reckoning these individual transactions, the entire prestation is recorded by one or more core donors: important men who publicly run along the rows in a stylised manner, counting objects in the collective gift. This action not only validates the name and prestige of core donors but the viability of the kin group itself—its ability to accumulate valuables demonstrates its attractiveness to exchange partners. The several thousands of spectators, whether attending the distribution as recipients or simply as onlookers, may therefore be so impressed by a well-done formal count that they will vie to send their daughters as wives into the clan making the distribution. The clan's well-being is also attested by a formal count, for had much illness or death (often attributed to enemy actions) struck the kin group, pigs and pearlshells would have been dissipated in curing rites and in immediate funerary distributions.

The core donor (or donors) runs along the row of valuables tapping the stakes or the objects themselves in the following manner:

Speaker	Gloss	English number
i talu	here 2!	2
i talu kise	here 2 4	4
i talu	here 2	6
i talu kise engaki	here 2 4 8	8
rureponga talu	2 of 12	10
rurepo	12	12
malapunga talu	2 of 16	14
malapu	16	16
supunga talu	2 of 20	18
supu	20	20
tokapunga talu	2 of 24	22
tokapu	24	24
alapunga talu	2 of 28	26
alapu	28	28
polangipunga talu	2 of 32	30
polangipu	32	32
tokapu poranimbe engaki	24 finished, 8 are	
ngoli lekemo	left remaining	
engaki	8	

rureponga talu	2 of 12	34
rurepo	12	36
malapunga talu	2 of 16	38
and thus along to:		
tokapunga talu	2 of 24	46
tokapu	24	48
then:		
tokapu talu poranikimi,	2 tokapu (2 sets of	
kelepa alapu angilikimu	24) are finished,	
	again alapu stands	
alapunga talu	2 of 28	50
alapu	28	52
polangipunga talu	2 of 32	54
polangipu	32	56
tokapu talu poranimbe,	2 tokapu are finished,	
enggaki angilikimu	8 remain standing	
enggaki	8	
rureponga talu	2 of 12	58
rurepo	12	60
and so on.		

Large numbers are thus counted in named sets of 4 to 32:

kise	4	supu	20
enggaki	8	tokapu	24
rurepo	12	alapu	28
malapu	16	polangipu	32

If fewer than 5 objects then remain to be counted, the counter may proceed, say, to 35 as follows: *awili kalinga talu* (two of the big needle), *awili kali* (big needle), *kanga kalinga telu* (one of the small needle). The terms *awili kali* and *kanga* (or *kelu*) *kali* may apparently be interchanged without affecting the meaning. Some counters do not use these terms at all. We are unsure of the rules for including *awili* or *kanga kali*.

The basic Kakoli set, however, is *tokapu* (24), because one can proceed to *tokapu talu* (48), *tokapu yepoko* (72), to *tokapu tokapu* (576) whereas one cannot say, for example, **malapu talu* to express 32 or **alapu talu* to express 56.

The person counting proceeds by twos through named sets of four. Unlike English and Pidgin numeration, when a set of four has been completed, the next three items are considered parts of the following named set rather than additions to the just-completed set, e.g., *supunga talu* "2 of 20" i.e., 18. (The suffix *-yga* is a simple possessive, cf. *na* "I, me" and *nayga koygi* "my pig.") Oliver¹⁰ reports a similar usage among the Siuai of Bougainville; "nine", for example, is expressed as "4-towards-10".

If the objects to be counted total less than a named set of four, the total is expressed as part of the next named set, for example, *supunga yepoko*, "3 of 20" i.e., 19.

10. Oliver 1955.

Numerals for 5 and 6 are essentially epiphenomena and are used only in counting sets of 24. Numerals for "one", "two" and "three" in addition are used as "uneven" numbers when the quantity to be counted does not add up to four.

A further point of difference from the rules of Western counting systems is that the counter cannot proceed directly from one set of *tokapu* (24) to the next; he must go through the numbers *alapu* (28) and *polangipu* (32) (but not *awili kali*), then collect these as "one set of *tokapu* is finished, eight remain" before moving on to *rurepo* (12) of the next set of 24. This is an esoteric feature of the system; inept counters or beginners fumble over this detail.

The man counting may place a stick after each set of 24 or he may carry the entire number in his head. Elaborate tallies are not an intrinsic feature of Kaugel numeration. The *kaparele* (Melepa: *omak*) is a chain of *Miscanthus* or bamboo pieces cut into 3-or-4-inch lengths and strung, parallel, on a fine rope around the neck. Although today young Kaugel men wear the *kaparele* simply as an ornament, originally a new length was added each time the wearer made a distribution. Whether to count certain transactions as one or more distributions was a decision left to the wearer. The *kaparele* functioned not to remind the owner himself of the number of distributions he had made, but rather to impress others about his activity in the prestige economy. Similarly, among those clans who today distribute large numbers of live and dead cassowaries (Yano clan in the upper Kaugel and some upper Mendi clans), lines of transverse posts tallying each bird distributed probably function more as a spectacle to impress rivals rather than as reminders to individual donors.

DERIVATION OF THE KAUGEL FORMAL COUNT

The Kaugel counting system, based on named "numbers" in sets of 4 and 24, is abstract. That is, it is not based on finger-counting or tallying of other body parts—at least not in the local Kakoli language. In the Kaugel, fingers are named as follows:

<i>ngale</i>	"little finger"
<i>narekili</i>	"next finger"
<i>kamako</i>	"chief, foremost finger." Cf. <i>kerā kamako</i>
	"eagle" or <i>ye kamako</i> "Big Man"
<i>sundu</i>	"index finger"
<i>pambu</i>	"thumb"

The whole hand, or arm, is *ki*, from which *kise* "four" and perhaps *eggaki* "eight" are derivable; cf. *kise* "hand of pandanus"—made by tightly tying ripe pandanus seeds by their bases to a stick some 30 to 40 inches long in order to cook them over a fire. The everyday system was probably derived from finger counting. But for further understanding of the genesis of the system, we must turn to the local languages of neighbouring peoples: Melepa, Kewa, and Enga dialects. Mendi numbers, which might be instructive, are not available to us in Auckland.

If Kaugel numeration features are of some antiquity, we would expect

to find traces of them in the Kewa and Enga languages of Wurm's West-Central Family,⁽¹¹⁾ or at the least, in Melepa—another member, with Kakoli, of the Hagen Sub-Family of Wurm's Central Family. Melepa and Kakoli are closely related languages; the number of cognates is very high. Bunn and Scott,⁽¹²⁾ for example, list 70 percent cognates between Medlpa and Gawigl while Wurm⁽¹³⁾ reports 72 percent. Unfortunately, the particular dialects upon which cognate counts are based are not specified in the literature. For peoples living along the western bank of the upper Kaugel river, Melepa is a foreign language which can, however, be learnt fairly readily—as compared, say, to Enga or Kewa—once one has become accustomed to the sound changes that preclude easy comprehension. Melepa numeration must also be learnt; only the term for "two" follows regular sound changes.

Vicedom and Tischner list Melepa numbers up to 24: *ki raklitika* "three hands" or perhaps three handfuls of fingers. There appears to be nothing significant in the fact that Vicedom and Tischner's list stops at 24; they state that numbers can be formed up to about 80, in sets of fours and eights. Cognates retaining the same meaning are confined to *rakl* "two" and possibly *enkaka* "eight" although Melepa *pombi* "five, thumb" is probably a cognate of Kakoli *pambu* "thumb". The term *ki* ("hand" in Kakoli and other languages as well as Melepa) appears prominent in numbers from 16 on. It is possible that *-pokət* as in *tembokakapokət* "twelve" may be related to Kakoli *yepoko* "three". But the Melepa numbers, as a system, are quite unrelated to Kaugel numbers. They appear to form an eight-base system superimposed upon a four-base.

When Enga and Kewa numbers are compared with Melepa and Kakoli, it appears that primary numbers—that is, numbers through four—are cognate throughout this area which encompasses speakers of the two language families. For example, "two": Hagen (Melepa) *rakl*; Kakoli *talū*; Kewa *lapo*; Enga dialects (Crotty) *rab*; (Lang) *lápó*, *lapóma*, *lapotá*; (Baptist Mission Baiyer River) *lama*. And "three": Melepa *raklitika* seems to be an exception; Kakoli *yepoko*; Kewa *repo*; Enga dialects (Crotty) *teb*; (Lang) *téma*, *tépo*, *tepóma*; (Baptist Mission Baiyer River) *rema*. Regarding "four", all these languages (except Melepa of Hagen where *ki dende* "one hand" is "eight") incorporate *ki* "hand" in the numeral: Kakoli *kise*; Kewa *ki*; Enga dialects (Crotty) *kirúmend*; (Baptist Mission Baiyer River) *kisima*; (Lang) *kitómende*, *kitúmende*. From "five" on, however, the numerals diverge: Melepa *pombi* "thumb, five"; Kakoli *telupakara* "five", Kewa *kode* "thumb, five", or *kina kode* "hand's thumb, five"; Enga dialects (Crotty) *juúnk* or *juúnki*; (Baptist Mission Baiyer River) *kigi páka*; (Lang) *yángi púndu*, *yáu*, *yáunge*, *yuungi*. Five and further numerals partly depend upon whether the system is base-four, as amongst Melepa, Kakoli, and Kewa speakers⁽¹⁴⁾ or base-five as is reported for the Enga.⁽¹⁵⁾ The Enga are said to use a base-four system for some

11. Wurm 1971.

12. Bunn and Scott 1962.

13. Wurm 1971:55.

14. Where "twelve", for example, is three times the basic set of four.

15. Wolfers 1971:80.

formal counts.⁽¹⁶⁾ Presence of some special and alternative forms for "eight"—(Crotty) *tuguráb*; (Baptist Mission Baiyer River) *akalisa mage lama* or *ilyápigí* "bow finger"⁽¹⁷⁾ (Lang) *mange lao waketau, tukulápo*—indicates that the four-base and five-base systems amongst the Enga exist side by side although we cannot state the Enga-wide context in which each is used.

We suggest that the four-base system is ancient in the Western Highlands/Southern Highlands/Enga Districts, probably derived originally from finger counts, and that contemporary formal counting systems reflect separate developments since these languages, even Melepa and Kakoli, have diverged.

One day's walk to the east, south, north-west, or north from the territory of Kepaka and Sipaka clans takes one to areas where the 24-base numeration system of the upper Kaugel is absent. One of us (P.L.) has heard terms similar to those reported by Vicedom and Tischner in use along the lower Nebilyer near its confluence with the Kaugel river. We have heard Kaugel terms used at distribution ceremonies of Tendepo and Yano clans despite the presence of important Enga-speaking Tchak valley individuals. We are not able to further delineate the boundaries of various Western Highlands-Southern Highlands-Enga District numeration systems.

Formal counts, involving higher numbers, are used exclusively in an exchange context. Our material is focussed on the area around Puluwa and Kiripia in the upper Kaugel. People a few miles south of Kiripia have extensive exchange relations with Kewa-speaking peoples. From Kiripia north west to Opiopulu, most exchanges occur within the Kaugel valley, with some clans of the Tomba (upper Nebilyer) area, with Kakoli-speaking upper Mendi clans, and to some extent with middle Nebilyer peoples. Prestige exchange, involving relatively few persons as primary participants, extends into the Tchak valley Enga. North of Opiopulu, from Yano through Aiaka clan territories, exchange and marital relations involve not only peoples of the Kaugel valley but also upper Mendi, Kandelega (Kandep), Tchak valley, the upper Nebilyer, and as far north-west as the Wapenamanda area of the Lai valley. Along the eastern bank of the Kaugel, traditional extra-valley relations extend beyond the eastern bank of the middle Nebilyer, into Melepa-speaking areas. Thus exchange relations can best be described as chains of networks, and numeration features in formal counts may spread beyond their primary areas of origin.

Higher Kakoli numbers—those beyond "eight"—have no obvious cognates in Melepa nor in any of the Enga dialects. However, in the Kewa body count system⁽¹⁸⁾ *maala* or *mala* "index finger" is "four", and *su* "thumb" or *supu* in West Kewa, is "five". In the Kewa four-base system⁽¹⁹⁾ *ki mala* is 16 and *ki su* is 20—note Kakoli *malapu* (16) and *supu* (20). The term *repo* is "three" in the Kewa four-base system and "three" in

the West Kewa body count. This is related not only to Kakoli *yepoko* "three" as a cognate but moreover to Kakoli *rurepo* "twelve" as a borrowing. Thus the Kakoli higher numbers *rurepo*, *malapu* and *supu* in the Kaugel formal count derive quite directly from Kewa numerals with some change in form and meaning. We do not know by what means these Kewa numbers entered the Kaugel counting system.

We have not been able to locate prototypes in neighbouring languages for Kaugel numbers above *supu* (20). *Tokapu*, the unit 24, does not seem, from the materials published by the Franklins, to derive from any Kewa numeral. We have no firm suggestions to account for *tokapu* as a basic Kaugel unit. In a personal communication, Ralph Bulmer has pointed out that the mid-point of both East and West Kewa body counts is *rikaa* (24). South Kewa, however, count a total of 35 body parts⁽²⁰⁾ while Strauss and Tischner⁽²¹⁾ illustrate a 44 body count from an unspecified Kewa-speaking area. In the Kaugel itself, distributions of pearlshells by individuals are usually made in blocks of four or eight—corresponding to some extent with the joints of pork due, when pearlshells are converted into pigs, to the auxiliary donors. The only local context we know which involves a unit or multiple of 24 is housebuilding; 48 (*tokapu talu*) is the ideal number of houseposts (*ponga*) necessary to accumulate in advance of the construction, although longer homes such as those shared by two nuclear families require more.

Above *tokapu* (24), the only clear derivation which can be found is the numeral for 28, *alapu*, which is also the term for the extensive bridal payment which remains after the main formal prestation has been made.

Kali, sometimes used in short formal counts in the Kaugel as *kali awili* or *kali kanga* (36 or 40), refers not only to "needle" but also to the bone from which traditional needles are made: the radius bone of the arm, and to the fibula of the leg. In the Kewa body-count system,⁽²²⁾ *noe* means "needle" or "radius". Thus this Kaugel feature may have some relation to Southern Highlands body-count systems.

We have not found any possible derivation for *polangipu* (32) in Kakoli or in nearby languages. The suffix *-pu* which occurs only with higher numbers above *engaki* "eight" (besides the obvious relation of *rurepo* "twelve" there are phonological grounds in Kakoli for *rurepo* rather than **rurepu*) may be a direct borrowing from the Kewa numeral suffix *-pu* "continuing on".⁽²³⁾ It may be related to Kakoli *pu* "basal sucker, especially of pandanus" or to *-pu* "base, lowest area" as Koltapu. Cf. Enga *itáki pingi* "to count" and *pingi* "to hit, kill" and "tree root, root".⁽²⁴⁾

How ancient is the contemporary Kaugel formal counting system? While some higher numbers and other features of Kaugel numeration derive from Kewa terms, the system as a whole with its 24 base super-

16. *Loc. cit.* and Ralph Bulmer, personal communication.

17. Ralph Bulmer, personal communication.

18. Franklin 1968.

19. Franklin and Franklin 1962.

20. Franklin 1968.

21. Strauss and Tischner 1962:8.

22. Franklin and Franklin 1962:189; also Strauss and Tischner 1962:8.

23. Franklin 1968:34.

24. Lang dictionary. "Count" in Kakoli is *kambu*; imperative singular *kambu ta!*

imposed upon a four base and its formal feature of counting beyond 24 to 32 then assembling the last eight to start the next set of 24, is a unique local development. For its public features, it depends upon the accumulation of large amounts of valuables including pigs and thus upon a heavy-yielding agricultural base—in its present form inconceivable without permanent sweet potato mound fields. The analysis of vegetation patterns and social features made by one of the authors⁽²⁵⁾ suggests that contemporary man-land relations in the high-altitude Kaugel valley is an expanding one and that the present agricultural landscape may be no older than some 200 years. Both of us are confident that the formal Kakoli count may date no further back.⁽²⁶⁾ The Enga ten-base system similarly may be a recent change to the previous regional four-base numeration.

Surrounding this core area where we have postulated an original four-base numeration are various sorts of body counting systems.⁽²⁷⁾ Body counts may have preceded the four-base, essentially digital count. In more recent times, the proliferation of body count systems may have accompanied less rapidly expanding prestige economies.

PANDANUS COUNTS AND FRACTIONS

In the Kaugel valley, formal count terms are used for some everyday features that cover large numbers, such as in reckoning the number of posts needed to build a house, or the number of householders and visitors who must be fed. A slightly different numeration domain concerns the counting of pandanus fruits—fruiting heads of wild and cultivated varieties of *Pandanus julianettii* Martelli. Fruits are usually cut from the tree after the fat white seeds have developed but before the fruit is entirely ripe—i.e., before the stem base and basal mesocarp soften and free the fruiting head with individual seeds. In the forest, the collector cleans the fruiting head of much non-edible material—thereby reducing the carrying weight—splitting each head, and binds the halves together again at the end of a carrying pole which is borne on the shoulder. The unit of measurement is the pole with a trimmed fruiting head bound at each end, *pupu te*.

25. Bowers 1968, 1971.

26. Hughes 1973:105 says "The shell trade grew greatly during the first 30 years of this century and was probably in effect a diffusion wave of traditional wealth objects made possible by pacification on the coast and in part due to devaluation of old wealth forms there by new forms introduced by whites." While Hughes is probably referring to the north coast, and our Kaugel best-regarded valuables (other than axe blades) came from a southerly direction through Kewa-type intermediaries, we would agree with a date of less than 100 years for the present Kaugel formal count. In our view, Hughes makes too little of the recent expansion of sweet potato agriculture and farmers into high-altitude valleys. Some of the effects of this pioneering were to make more high-altitude products available for exchange: pandanus seeds, cassowaries and other game, a few kinds of plumes, and more pigs. At the same time, the potential crowd of buyers for shell valuables was increased.

27. Wolfers 1969, 1971; Franklin and Franklin 1962; Franklin 1968; Williams 1940; Ralph Bulmer personal communication; Graham Jackson personal communication; Aufenanger 1938; Kirschbaum 1938; Wagner 1967. This suggestion again follows a comment by Ralph Bulmer.

Thus:

<i>pupu te mongo</i> ⁽²⁸⁾ <i>te</i>	"three pandanus fruits"
<i>pupu talu</i>	"four pandanus fruits"
<i>pupu talu mongo te</i>	"five pandanus fruits"
<i>pupu yepoko</i>	"six pandanus fruits"

and so on.

A person who has collected and carried fruits-on-a-pole down to his home in the settlement area will want to give some pandanus, raw or cooked, to his neighbours. Half a fruiting head, with the edible basal mesocarp still intact, is *pangare*. If the harvest is small, or the number of recipients is large, one may not be able to distribute as large a section as *pangare* "half a pandanus fruit" to each household. The fruit can then be further split, into quarters: *ilisi* ("slice", used mainly for pandanus). The *ilisi* can be split once more into eighths—this time a horizontal cut—*pikelele* "piece" (from *pike* "break or split for sharing").

When dividing a relatively homogeneous object, such as a pandanus fruit, by hand, it is obvious that the object can be split most efficiently into halves, and those pieces again halved into quarters, than to choose some measure more awkward to the eye, such as thirds or tenths. But when vernacular numbers are to form the basis of either abstract mathematics or machine-calculated accounting systems, for efficiency's sake it is necessary not only that the whole entities be figured in terms of consistent sets but also that the parts or fractions be consistent with the entire system. Because eye-based systems of fractions—halves, fourths, eighths—prevailed in pre-metric Western systems while whole units were commonly counted in tens, it has become necessary for Western countries to shift to centimetres and millimetres—units difficult to divide by eye. Four-based numeration systems such as those of the Western and Southern Highlands have an inherent advantage in that their parts are congruent with their wholes.

OTHER KAUGEL SYSTEMS OF RECKONING

Different, mainly sequential, numbering systems are used in the Kaugel for ordering or reckoning certain qualities, quantities, or social features.

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

Sibling sequence, especially for males, is important. The eldest son is looked upon as a ritual and economic replacement for the father; he is commonly provided with a wife and land resources at an earlier age than are subsequent sons; as a young boy he is taught his father's business transactions and social obligations. He is instructed early in formal behaviour for giving and receiving prestige items. Should the father die before all the children are grown, the eldest son generally assumes

28. *mongo* = "eye, fruit, seed".

responsibility for younger siblings. Younger sons have fewer responsibilities but seldom become as renowned as their eldest brothers.

Hands of bananas are counted in a similar way, beginning the sequence at the basal end of the infructescence.

Children's or siblings' birth order can also be expressed in the following way:

Na komo. "I am the first-born".

Imu nangu mbulukundumu. "That (he or she) is my backbone follower".

Kilinga mbulukundumu Yako. "Kili's backbone follower is Yako".

Yakonga mbulukundumu Kuse. "Yako's backbone follower is Kuse".

Kusega mbulukundumu Mapele akilyomo. "Kuse's backbone follower is Mapele, the last-born".

Months are counted in six pairs of first-born and last-born:

siliki komo akilyo tsolo "(month-) pair Siliki elder, younger".

owele komo akilyo tsolo "[month-] pair Owele elder, younger"

siri komo akilyo tsolo "[month-] pair Siri elder, younger"

kondole wambu komo akilyo tsolo "[month-] pair Red Wambu elder, younger"

sipeno komo akilyo tsolo "[month-] pair Sipeno elder, younger"

pellu komo akilyo tsolo "[month-] pair Pellu elder, younger"

Position of the rising sun along the eastern mountains marks the months of the year. As the sun retreats northward in June, people note that frosts may occur. Some say that if the rising sun were to proceed even further northward, out of the valley entirely, then the valley would be struck by total disaster! New months commence with the smallest sliver crescent of the new moon.

It will be noted that a time-reckoning system of 12 months with 28 days each requires the addition, at intervals—say yearly or biennially—of an intercalary month in order to prevent the months and their appropriate seasons from getting too far out of adjustment. See Meggitt's discussion of the Enga calendar.⁽²⁹⁾ We are unsure of the method by which such an extra month is inserted in the Kaugel.

Reckoning months is of particular interest when events are being planned: so that the occasion may be held during suitable weather, and so that other events near by and in distant localities may be co-ordinated. A few men understand the intricacies of the local calendar and their advice is sought. Many adult men are even unsure of the sequence of months. Originally, Kaugel people did not count in years, although the terms "Christmas" and *ponya* "field, garden" are used nowadays.

Although days of the month were not numbered, the Kaugel language can unambiguously reckon days before and after the present:

<i>ambiaka</i>	"four days before today"
<i>yuluaka</i>	"three days before today"
<i>talo</i>	"two days before today"
<i>mbonongo</i>	"yesterday"
<i>kinia</i>	"today, now, the present"
<i>opali</i>	"tomorrow"

29. Meggitt 1958.

<i>talu</i>	"two days from today"
<i>yulu</i>	"three days from today"
<i>ambi</i>	"four days from today"
<i>pupiriki</i>	"five days from today"
<i>eroko</i>	"six days from today"
<i>toyolu</i>	"seven days from today"
<i>weyakupulu</i>	"eight days from today"

Counting ahead, few Kaugel people fail to become confused after *ambi*; reckoning back, as may be obvious from this list, few know the appropriate term beyond *ambiaka*. Day markers are used mainly in immediate future plans rather than in discourse about past events more distant than *talo*.

These day-markers have some derivational relation to the numbers *talu* and *yepoko* ("two" and "three") but no discernible relation to body parts in Kakoli.

Ever since the Australian Administration began to corveé labour for road work and other public constructions, Kaugel people have been reckoning days of the European week:

<i>kongono pulupulu</i>	"base of work" i.e., Monday
<i>kongono talu</i>	"work two"
<i>kongono yepoko</i>	"work three"
<i>kongono kise</i>	"work four"
<i>kongono pambu</i>	"work thumb" i.e., Friday
<i>kora kanga</i>	"small rest" i.e., Saturday
<i>kora awili</i>	"large rest" i.e., Sunday

Thus we can see that body parts can readily be used in constructing new methods of counting and one need not assume that the presence of a term for a body part necessarily indicates antiquity of the system.

CONCLUSIONS

Thanks to Wolfers' work,⁽³⁰⁾ it is probably unnecessary to address our remarks to the question, "Can peoples of Papua New Guinea count beyond three?" We have seen that the Kaugel system of counting proceeds from named sets of four to a base of 24, which for elegance in formal counting proceeds to 32, the last eight then being used to commence the next set of 24. The system proceeds to and beyond the square of 24, itself a recognised unit. Such a system can be used logarithmically. The system for dividing parts is congruent with the system for conceiving of wholes in a way that pre-metric English numeration was not. Such a system can be used for dealing with international finance or abstract functions; its main disability—besides the fact that Kaugel numeration is in use among fewer than 20,000 persons—is that it lacks written symbols.

We have suggested that Kaugel formal counting probably derived from a base-four system that seems to prevail across two language families of the Western and Southern Highlands and that some features seem to have been acquired from related languages: a basically internal development amongst peoples participating in a ramifying distribution

30. Wolfers 1969, 1971.

network. Another complex numeration system—at least one which handles large numbers, with a base of 60—occurs among the Kapauku or Ekagi of the Wissel Lakes area of Irian Jaya. We deplore the racist implications of Price and Pospisil's⁽³¹⁾ fanciful effort to derive Kapauku numeration from Babylonia and feel that a better understanding of the Kapauku system could be obtained by examining counting in its present context among the Kapauku and their neighbours.

The Kaugel method is not encumbered by awkward body-counting⁽³²⁾ devices or other features that would deter people from using the traditional system for precise reckoning of features important in the current and changing world of the Kakoli-speakers. But we feel that the metric system which school children now learn and adults learn by dealing with money will displace traditional counting methods, as it has already done, by government fiat, in many countries.

Franklin and Franklin⁽³³⁾ and others have been concerned that there may be learning difficulties for Highlands children exposed to the metric system in schools. We do not feel that Kaugel children have difficulty in moving from the local system to the metric. They learn them side-by-side—the one in the school context, the other in its cultural context. Adult men nowadays handle both with ease. But we believe that primary and secondary school teachers in Papua New Guinea, well-grounded in teaching the "New Mathematics"⁽³⁴⁾ should be aware of real local numeration systems for they illustrate far more forcefully than artificially constructed systems—for example, see Heimer and Newman⁽³⁵⁾—some concepts of modern mathematics.

Our primary purpose in describing Kaugel reckoning systems has been to record important cultural features which will sometime give way to the pervasive metric system. We furthermore felt that a dry listing of Kaugel numerals would not be meaningful. For Kaugel counting does not exist in isolation. It quantifies and qualifies relations between people, objects, and other entities. Birth order of siblings determines many other features of a person's life. And because the Kaugel people do not live just from day to day but plan the social relations which are so closely tied to distributions and sharings, a system—derived from birth order of siblings—exists for planning future events. The Kaugel formal count used in distributions is elegantly simple and capable of infinite extension. Its 4 and 24 base appears to be unusual even in the Western and Southern Highlands of Papua New Guinea.⁽³⁶⁾

31. Price and Pospisil 1966.

32. Ralph Bulmer comments that body counts can be rapid and efficient.

33. Franklin and Franklin 1962.

34. Again, we follow a suggestion made by Ralph Bulmer.

35. Heimer and Newman 1965:36-52.

36. A paper by Pumuge (1975) was received too late for comment in the body of our paper. Pumuge reports a body-count totalling 68 (also one totalling 51 in another village). The 68-unit body-count can be used in conjunction with the 4-base count to form a unit equivalent to 272. Pumuge also lists common Kewa fractions—halves, quarters, eighths and so on—eye-based, like their Kakoli counterparts. This new Kewa-Imbogu material further complicates the historical picture of the relations between 4-base systems, body-counts, and the Kaugel 24-base system.

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