Numeral Classifiers and Counting Systems in Polynesian and Micronesian Languages: Common Roots and Cultural Adaptations

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Polynesian and Micronesian languages inherited a decimal number system from Proto-Oceanic, and individually extended it on one or more dimensions: in length by adding terms for larger numbers, in breadth by specifying numeral classifiers for certain objects (prevailing in Micronesia), and in factor by introducing a larger counting unit (prevailing in Polynesia). Specific counting systems are characterized by a combination of these features: They are based on larger counting units (multiplication function) and apply to certain objects only (object specificity). This paper surveys the distribution of each extension type in Polynesian and Micronesian number systems, characterizes the features that they share, and analyzes the constitutive role that numeral classifiers play for specific counting systems. It is concluded that in most of these languages, number systems are composed according to similar principles, while the divergence in classifiers, objects of reference, and factors chosen results from cultural adaptations, some of which might have been responses to socioeconomic requirements and served purposes of cognitive facilitation.

1. INTRODUCTION: POLYNESIAN AND MICRONESIAN NUMBER SYSTEMS.[1] The core of number systems in Polynesian and Micronesian languages goes back to their common ancestor, Proto-Oceanic, and even traces back to Proto-Austronesian roots. Proto-Austronesian had a regular decimal counting system; ample evidence of this is provided both by its reconstructed numerals and by contemporary Austronesian languages (Tryon 1995). These decimal systems still prevail in most languages originating from Proto-Oceanic, the eastern-most branch of Austronesian. With only a small number of exceptions that are not relevant here, their words for the numbers 1 through 9 widely reflect the numerals reconstructed for Proto-Austronesian and Proto-Oceanic, and reflexes of the Proto-Oceanic (POc) term for 10,[2] *sa[-nga]-puluq (PPn *hanga-fulu, PMc *ngaulu), can also be found (Bender and Beller 2006; Clark 1999; Harrison and Jackson 1984; Lemaître 1985; and see table 1), despite a greater variability of terms for 10 in serial counting in Micronesia (Harrison and Jackson 1984).

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Beyond 10, most power terms were developed independently, but reached large numbers in both language families. Early forms of both Polynesian and Micronesian languages may have reached numerals for up to 10^6: *ki(l)u in Proto-Polynesian (Clark 1999:197) and *nena in Proto-Micronesian (Harrison and Jackson 1984:68). Although these forms are reconstructed by the respective authors only tentatively or were later regarded as speculative (Clark 1999:197; Jackson 1986:209), they nevertheless indicate the indigenous interest in large numbers, which is also clearly attested ethnographically for precolonial times (e.g., Elbert 1988:186,198; Elbert and Pukui 1979:161; Henry 1928:323).

TABLE 1. NUMERALS IN PROTO-AUSTRONESIAN, PROTO-OCEANIC, PROTO-POLYNESIAN, AND PROTO-MICRONESIAN†

Number	PAn	POc	PPn	PMc
1	*a-sa, *'e+sá, *i-sá, *sa-, *ta+sa	*ta-sa, *sa-kai, *tai, *kai	*tasa	*-sa, *te-sa
2	*d_3uSá	*rua	*rua	*ruwa
3	*tĕlú	*tolu	*tolu	*telú
4	*Sĕ(m)pát	*pati, *pat	*fā	*fa(a)
5	*limá	*lima	*lima	*lima
6	*'ĕném	*onom	*ono	*ono
7	*pitú	*pitu	*fitu	*fitú
8	*walú	*walu	*walu	*walú
9	?*siáw	*siwa	*(h/s)iwa	*s'iwa
10	*púluq	*sa(-nga)-puluq	*(hanga)fulu	*ngaulu
10^2		*Ratu(s)	*rau‡	*púkua [*pwukua]
10^3			*afe	*-ngaratu¤ (*kusi/kisi [*kudi/kidi])
10^4			*mano	(*lopwa)
10^5			(*tini)	(*sepu/sepi [*depu/depi])
10^6			(*ki(l)u)	(*nena)

† **Sources:** Proto-Austronesian (PAn) numerals are taken from Tryon (1995 (1): 1105–97; Proto-Oceanic (POc) from Lynch, Ross, and Crowley (2002:72); Proto-Polynesian (PPn) from Clark (1999); and Proto-Micronesian (PMc) from Harrison and Jackson (1984:63,66,68,70).
Notes: PMc terms in square brackets relate to a diverging spelling as used by Jackson (1986:209). PPn and PMc power terms in round brackets are regarded as speculative (Clark 1999; Jackson 1986:209).

‡ As POc *R is lost in Proto-Polynesian (cf. Geraghty 1990), PPn *rau could only be an irregular reflex of POc *Ratu(s). It is more likely that its root is POc *(n)dau, 'leaf', instead. For detailed lists of correspondences see, for instance, Bender et al. (2003), Biggs (1979), Clark (1999), and Jackson (1986).

¤ While originating from POc *Ratu(s), 'hundred', PMC *-ngaratu refers to 'units of thousands' (Harrison and Jackson 1984:69).

2. Language abbreviations (only used when referring to lexemes) are for *language families* PAn, Proto-Austronesian; POc, Proto-Oceanic; PPn, Proto-Polynesian; PMc, Proto-Micronesian; and PMP, Proto–Malayo-Polynesian; for *Polynesian languages* Haw, Hawaiian; Man, Mangarevan; Mar, Marquesan (with NW and SE referring to the Northwestern and Southeastern group respectively); Nuk, Nukuoro; Sam, Samoan; Tah, Tahitian; and Ton, Tongan; and for *Micronesian languages* Chk, Chuukese (or Trukese); Kir, Kiribati; Pon, Pohnpeian; and Wol, Woleaian (or Weneyan).

In a certain sense, these high numerals also reveal the characteristics of the respective systems: In Polynesian languages, some of these numerals are part of specific counting systems with apparently "mixed bases," whereas in Micronesian languages, power terms are typically considered as one type of numeral classifiers, namely as "numerative bases" (Benton 1968:109), "ten-power bases" (Harrison and Jackson 1984:64), or "digital classifiers" (Sohn 1975:81).

While information about specific counting systems in the older language forms (POc, PPn, or PMc) is not available, it seems justifiable to assume numeral classifiers in some of these old languages. Up to the present day, many Austronesian languages contain such numeral classifiers, albeit not evenly distributed: They occur in most Micronesian languages, where they abound, for instance, in Chuukese (Benton 1968) or Kiribati (Harrison and Jackson 1984:62), but only in a few Polynesian languages such as Samoan (Mosel and Hovdhaugen 1992) and Rennellese (Elbert 1988). In Polynesian languages, numeral classifiers are typically restricted to certain objects, with general numerals prevailing elsewhere. In Micronesian languages, on the other hand, general numerals are used only in enumerating a series or in an abstract sense (Harrison and Jackson 1984:64), whereas talking about a certain amount of objects always requires the use of a numeral classifier.

Etymological and syntactic parallels between some of these numeral classifiers and numerals used in the specific counting systems raise the question of whether and how these two systems are linked. In order to answer this question, we will first characterize the numeration principles of each type of system, before focusing on similarities and differences between these systems more thoroughly. To conclude, we will discuss the role of numeral classifiers for specific counting systems as well as their origin.

2. CHARACTERISTICS OF NUMBER SYSTEMS.

Before analyzing potential links between the Polynesian and Micronesian number systems, in this section we will identify some of the most relevant characteristics of each system: the range of power terms in the two language families, the specific counting systems with apparently mixed bases prevailing in Polynesia, and finally the numeral classifiers of Micronesia.

2.1 POWER TERMS.

As the two language families are (basically) decimal, their higher numerals typically refer to the powers of ten. As many languages developed their power terms locally, the extent to which most of them *did* develop such terms is all the more remarkable: although we also find languages in which the largest number denoted by a numeral did not exceed 10^3, these were the exception; on average, number systems extended up to 10^5 or 10^6, and in extreme cases went as far as 10^9 or 10^{10} (cf. table 2).

The only power term (above 10) inherited from Proto-Oceanic and (partly) shared by Polynesian and Micronesian languages might be *Ratu(s), the numeral for 100. It is reflected in PMc *ngaratu, where it refers to units of thousands, while PPn *(te)rau (100) could be a reflex only if we assume irregular retention of *R (cf. the second footnote in table 1). In contemporary Polynesian languages, *(te)rau is still widely reflected (Bender and Beller 2006; Clark 1999; Lemaître 1985), whereas PMc *ngaratu is reflected only in Proto-Chuukic and probably in Kiribati (Harrison and Jackson 1984:69).

For Proto-Polynesian, a second power term, *mano (denoting 10^4), can be reconstructed. It is reflected in nearly all contemporary Polynesian languages, yet with diverging values: from 10^3 in Nukuoro, Tahitian, Mangarevan, and Māori through 10^4 in Tongan or Rapanui up to 10^5 in Samoan. Apart from these numerals, variety increases, but reflexes of the reconstructions *afe (10^3), *tini (10^5), and *ki(l)u (10^6) can still be found in various languages (Bender and Beller 2006; Clark 1999).

In Micronesian languages, one power term—PMC *púkua (10^2)—is widely reflected. Beyond 100, however, the terms for the powers of the base again show a larger degree of variation. Reflexes of PMC *kusi/kisi (10^3) can still be found in about half of the Micronesian languages, yet with diverging values: as PON kid (10^3) or as

TABLE 2. TRADITIONAL NUMERALS FOR 10 (WITH ALTERNATE FORMS) AND THE POWERS OF THE BASE IN SOME POLYNESIAN AND MICRONESIAN LANGUAGES[†]

POWER LEVEL	POLYNESIAN LANGUAGES				MICRONESIAN LANGUAGES			
	MAN	TAH	TON	NUK	KIR	PON	CHK	WOL
10[‡]	rogo'uru	'ahuru	(hongo) fulu	hulu	(te)bwii(na) (te)ngaun	(e)isek ngoul ehk	(e)ngoon (e)ik	(se)ig (se)ngaul (se)yaf
	takau	ta'au	(te)kau	?	?ikoa			
10^2	rau	rau	(te)au	lau	(te)bubua	(e)pwiki	(e)pwúkú	(se)biugiuw
10^3	mano	mano	afe	mano	(te)ngaa	kid	(e)ngéré	(sa)ngeras
10^4	makiu	manotini	mano	(se)mada	(te)rebu	nen	(e)kit	(se)n
10^5	makiukiu	rehu	kilu	(se)guli	(te)kuri	lopw		(se)lob
10^6	makore	'iu		(se)loo	(te)ea	rar		(se)piy
10^7	mako-rekore	*tini 'iu / 'iu tini		(se)ngaa	(te)tano	dep		(se)ngit
10^8	tini	*rau 'iu		(se)muna	(te)toki	sapw		(sa)ngerai
10^9	maeaea	*mano 'iu		(se)bugi		lik		
10^{10}		*manotini te 'iu		(se)baga				

† **Sources:** Mangarevan (MAN) numerals are from Lemaître (1985) and MCSC (1908), Tahitian (TAH) from Henry (1928:324–25) and Lemaître (1985), Tongan (TON) from Churchward (1953), Nukuoro (NUK) from Carroll and Soulik (1973) and Harrison and Jackson (1984:72), Kiribati (KIR) from Bingham (1922) and Harrison and Jackson (1984:67), Ponapean (PON) from Harrison and Jackson (1984:67) and Rehg (1981), Chuukese (CHK) from Benton (1968) and Harrison and Jackson (1984:70), and Woleaian (WOL) from Harrison and Jackson (1984:67) and Sohn (1975).
Notes: Prefixes are omitted or placed in brackets for easier comparison. Numerals diverging in value from a strictly decimal pattern (e.g., by factor two in Mangarevan) are shaded. * (in TAH) indicates that it is not clear whether the construction is really indigenous. Among the Micronesian numerals referring to 10, it is always the numeral mentioned first that is used in general counting.

‡ Among the Micronesian numerals referring to 10, only one reflex of PMC *ngaulu—CHK *(e)ngoon*—is used in general counting. The others are used as follows (Harrison and Jackson 1984:70): KIR *(te)ngaun* in all counting systems except the general system; PON *ngoul* for days, food prepared in an earth oven, multistemmed plants, and small pieces, and WOL *(se)ngaul* for 10 groups, *seyaf* for 10 pieces of copra, and also for valuable shells and coins.

CHK *(k)kit* (10^4). KIR *kuri* (10^5), on the other hand, might be a borrowing from TON *kilu* (Harrison and Jackson 1984:76). Other power terms are shared only sparsely or not at all, and accordingly the number systems also diverge in extent (see table 2).

While variation among power terms occurs both in Micronesian and Polynesian languages, it should be stressed that especially within the Polynesian languages, even cognate power terms diverge considerably with regard to their value. Not only may they differ with regard to the power level, but they may also refer to values that are different from the pure powers of ten (e.g., in Mangarevan), as will be addressed in more detail in the next section.

2.2 MIXED BASES AND SPECIFIC COUNTING SYSTEMS IN POLYNESIAN LANGUAGES. In 1906, Best published an article in which he argued that Māori employed binary and (semi-) vigesimal systems of numeration. Generalized for other Polynesian languages, this opinion was widely shared by colleagues in his time (e.g., Alexander 1864; Large 1902; Smith 1902:216; Tregear 1969 [1891]:503–4) and has influenced descriptions of traditional number systems until recently (e.g., Bauer et al. 1997; Hughes 1982). Indeed, many Polynesian languages do comprise a specific term for 20, and in some we find numerals for 200, 2,000, and so on. However, a genuine vigesimal system requires not just an emphasis on 20 itself, but its recurrence in *powers*, that is at $20^1 = 20$, $20^2 = 400$, $20^3 = 8{,}000$, and so on. None of the Polynesian languages yielded anything close to such a recurrence of powers. What we find instead are cyclic patterns at $2\times10^1 = 20$, $2\times10^2 = 200$, and $2\times10^3 = 2{,}000$. A number system containing such patterns might rather be termed a mixed-base 2 and 10 system or a decimal system operating with a pair as the counting unit.

Let us briefly illustrate the principles of a mixed-base system and its usage in Polynesian languages with the case of Māori (table 3; for more details see Bender and Beller 2006). Traditional Māori contained two different counting systems (supplemented by a third, hybrid type for counting people, not considered here): One is called the single mode (*tatau takitahi*), the other the dual mode (*tatau tōpū*). Counting in the single mode applied reflexes of the Proto-Polynesian numerals for 1 to 10 and the power terms *rau* (10^2) and *mano* (10^3). According to Best (1906:167–68), *mano* also set the limits for counting, while any amount beyond this was referred to as *tini*. In addition to the Pan-Polynesian term for 20 (*tekau*), multiples of 10 were composed by *hoko-* and the numeral with which 10 was multiplied (e.g., *hokorima* = *hoko*-5 = 50). Counting in the single mode was the general way of counting and was carried out in reference to most objects, while counting in the dual mode was restricted to a few objects such as fish, fowl, and certain root crops.

Counting in the dual mode applied the same numerals as counting in the single mode (except for *tekau*). However, these numerals were not used to refer to single items, but to pairs (*pū*). For instance, when a fowler collected his prey, he counted the first two birds as 1 (*tahi pū*), the second as 2 (*rua pū*), and so on. In some instances of counting—and especially so with smaller numbers—*pū* or *tōpū* (pair) was added to the number term, but usually it was left out as there seems to have been a shared understanding of the pair as the counting unit. When the counting proceeded in the single mode (*takitahi*), however, it had to be made explicit (Best 1906:161).

Similar principles of mixed-base systems can be found in several other Polynesian languages (for a selection, see table 4). In most languages, these mixed bases involved one or more of the factors 2, 4, 10, and 20. Some of these specific systems may have been used in general (such as, probably, the ones in the Marquesas), but for most languages, certain objects are documented as exclusive domains of applicability (Bender and Beller 2006). Tahitian, for instance, applied two systems of counting: a pure decimal system for general things and a dual form—that is in pairs—for counting bonitos, house thatch, breadfruit, and coconuts in great quantities (Henry 1928:323–26). The pair counting system diverged from the general system from *ta'au* (= 20) onwards, but still applied the regular higher numerals, now denoting powers of 10 times 2. For Mangarevan, four modes of counting are even reported, each specific for certain objects (two modes are presented in table 4). Breadfruit, pandanus leaves, agricultural tools, and sugar cane were counted in pairs (*tipau rua*); ripe breadfruit and octopus were counted in fours; and the first breadfruit and first caught octopuses of the season to be given as a tribute to the owner were counted in bunches of eight. All other things (including humans, mammals, or birds) were counted singly (*tipau tahi*) (Lemaître 1985:10; MCSC 1908:18–21). In parts of the Marquesas, counting seems to have applied only one system, with a preference for 2 as the counting unit in the Southeast,

TABLE 3. SINGLE MODE AND DUAL MODE OF COUNTING IN THE TRADITIONAL MĀORI NUMBER SYSTEM†

NUMBER	SINGLE MODE tatau takitahi	DUAL MODE tatau tōpū	COMPOSITION
1	tahi		
2	rua	tahi pū	1 · 2
3	toru		
4	whā	rua pū	2 · 2
5	rima		
6	ono	toru pū	3 · 2
7	whitu		
8	waru	whā pū	4 · 2
9	iwa		
10	**ngahuru**	rima pū	5 · 2
20	tekau	**ngahuru** pū	10 · 2
100	tahi **rau** takitahi	hokorima [pū]	50 · 2
200	rua rau (takitahi)	tahi **rau** [pū]	100 · 2
1,000	tahi **mano**	rima rau [pū]	500 · 2
	[**tini**]	tahi **mano** [pū]	1,000 · 2
		[**tini**]	

† **Source:** Adapted from Bender and Beller (2006), and see Best (1906).
Notes: Prefixes are omitted for easier comparison; power terms are highlighted boldfaced.

and 4 in the Northwest (however, the former also contained a specific numeral for 40, and the latter a specific numeral for 20). Likewise, in Hawaiian, all power terms—from 40 onwards and probably exceeding as high as 4,000,000—referred to powers of 10 times 4. Here, we again find some indication of the parallel usage of different systems, as specific objects were counted with specific terms, such as 40 fish referred to by *ka'au* or 40 tapa or canoes by *'iako* (Alexander 1864:14).

Two aspects are particularly noteworthy here. First, these apparently mixed-base systems are still decimal systems that only apply counting units diverging from 1. And second, in most instances, these mixed-base systems are accompanied by regular decimal systems, but are restricted to certain objects. Other instances with more complex systems will be illustrated further below. They combine diverging counting units for certain objects with numeral classifiers. Before analyzing these in more detail, we will characterize numeral classifiers with instances from Micronesian languages, where they are generally more pronounced.

TABLE 4. SPECIFIC COUNTING SYSTEMS AND THEIR OBJECTS OF REFERENCE IN FIVE POLYNESIAN LANGUAGES, SPECIFIED FOR COUNTING UNITS 1, 2, AND 4†

	TAHITIAN		MANGAREVAN‡		MARQUESAN [SE]			MARQUESAN [NW]			HAWAIIAN	
	1	2	1	2	1	2	4	1	2	4	1	4
10^1	'ahuru	ta'au	rogo-'uru	**takau** / paua	'umi	tekau	toufa	'ono-hu'u	tekau	touha	'umi	**ka'au**[(a)] **'iako**[(b)]
10^2	rau	rau	?	rau	?	'au		?		'au	?	lau
10^3	mano	mano		mano		mano				mano		mano
10^4	manotini	manotini		makiu		tini						kini
10^5	rehu	rehu		makiukiu								lehu
10^6	'iu	'iu		makore								(nalowale)
10^7	(…)	(…)		makore-kore								
10^8				tini								
10^9				maeaea								
OBJECTS OF REFERENCE												
	general	bonito, thatch, bread-fruit, coconuts	general	breadfruit, pandanus, tools, sugarcane		?	?		?	?		(a) fish (b) tapa, canoes

† **Sources:** Tahitian numerals are from Lemaître (1985) and Tregear (1969), Mangarevan from Lemaître (1985) and MCSC (1908), Marquesan from Lemaître (1985), and Hawaiian from Alexander (1864) and Elbert and Pukui (1979).
Notes: Prefixes are omitted for easier comparison. Specific numerals not part of the decimal systems are highlighted; counting systems diverging from a strictly decimal pattern are shaded.

‡ Two further modes of counting (with counting units 4 and 8) are restricted to octopus and breadfruit.

2.3 NUMERAL CLASSIFIERS IN MICRONESIAN LANGUAGES. In most Micronesian languages, numerals occur either as general numerals or as bimorphemic compounds. General numerals are only used in enumerating a series, that is, in abstract or rapid counting. Typically, serial counting involves the numerals up to 10 and restarts from 1 every time a multiple of 10 is reached (Benton 1968:106; Elbert 1947:23; Harrison and Jackson 1984:64,75, n.8). The number words otherwise used are bimorphemic, consisting of a numerative prefix as the first component and a classifier as the second. As suggested by Benton (1968) or Harrison and Jackson (1984), these classifiers should rather be regarded as "countable bases" of three or four types. With slight variations depending on terminology and assignment (Benton 1968:116; Harrison and Jackson 1984:62–64; Sohn 1975), the categories thus distinguished are:

(a) Repeaters (set labels for individual classes of objects; they repeat the phonological form of the sole noun with which they cooccur),
(b) Quality classifiers / qualitative or sortal bases (referring to salient features of the objects),
(c) Quantifiers / quantitative or mensural bases (indicating a quantitative measurement), and
(d) Digital classifiers / numerative or ten-power bases (referring to the powers of the mathematical base 10).

Benton (1968:109) sets the "numerative bases" aside from the other three categories, which he groups together as "classificatory bases" (see also Sohn 1975), whereas Harrison and Jackson (1984:62–64) regard the "ten-power bases" as part of the "quantitative bases."[3] None of these categorizations, however, provides mutually exclusive dimensions. Repeaters, for instance, form a category defined by morpholexical features, whereas qualifiers and quantifiers are defined by content. In addition, the group of the power classifiers cuts across the other categories, as from 10 onward—with just a few exceptions (detailed further below)—they replace other classifiers in all compounds referring to power terms or their multiples (Harrison and Jackson 1984; Sohn 1975:81). In Woleaian, for instance, counting animates typically classified with *-mal* provides the pattern illustrated in table 5.

All Micronesian languages (except for contemporary Marshallese) contain such numeral classifiers, but variation is large with regard to the degree of differentiation. It ranges from a binary system in Kosraean to a system of more than one hundred classifiers in Kiribati or Chuukese (Harrison and Jackson 1984). Five of these can most likely be traced back to Proto-Micronesian (Jackson 1986:209): the qualifiers *-ua (general objects), *-manu (animate objects), and *-cau (thin flat objects), and the two power classifiers *-ngaulu (units of tens) and *-pwukua (units of hundreds). With regard to the content of the numeral classifiers, it is difficult to draw a coherent picture.

3. In this paper, we deal not only with linguistic categories, but also to a great extent with mathematical notions. In order to avoid terminological confusion, in the following we will therefore (except in quotations) restrict the term "base" to the mathematical notion of a base (typically 10) and the term "power" to the powers of this base. Consequently—and despite the fact that we agree with the theoretical point put forward by Harrison and Jackson (1984)—we will have to refer to their countable bases as *classifiers* and will label the subcategories *repeaters*, *qualifiers*, *quantifiers*, and *power classifiers*, lacking better terms at this time.

Although in closely related languages some of the classifiers do match (at least 59 percent of the 22 classifiers given by Alkire [1970] for Woleaian can be identified in Benton's [1968] list of Chuukese), differentiations and labeling found in each single language are idiosyncratic to a considerable degree. However, it seems that only a few "semantic domains" (Benton 1968:136) are typically covered, while the remaining majority of objects are placed into a general or unspecified category. In Chuukese, these semantic domains are shape, nature, and generality (see Benton 1968:138, fig.1)—a distinction that also fits most of Silverman's (1962) list of Kiribati qualifiers.

One of the most extensive systems of numeral classifiers is documented for Chuukese (Benton 1968; Dyen 1965; Elbert 1947). In addition to the four "numerative bases" (i.e., power classifiers), Chuukese also contains 101 "classificatory bases" (Benton 1968:119–23). The latter consist of 65 repeaters, 21 quantifiers, and 14 qualifiers; one classifier belongs to two categories, while two others are not specified. Most nouns occur either with only one classifier or are "mechanically determined," as they do not change in meaning when combined with more than one (Benton 1968:111).

For our comparison of specific counting systems and classifier systems, the category of *quantifiers* is of particular interest, as it refers to enumerable or measurable quanta. Besides encompassing classifiers that refer to units of objects, this category also includes classifiers with a fixed numerical value, namely the power classifiers, as well as others that seem to change the numerical value of the adjoined numeral. In Chuukese, quantifiers typically refer to portions of food and to other units of counting and measuring. Most of these counting units are numerically imprecise—such as *-wumw* (bunch)—but five of them also imply a specific value (cf. Benton 1968:119–23; Dyen 1965:16–17; Elbert 1947:24–25; and see table 6 overleaf):[4]

TABLE 5. PATTERN OF QUALIFIERS (*-MAL*) AND POWER CLASSIFIERS (*-IG, -BIUGIUW*) IN COUNTING ANIMATES IN WOLEAIAN[†]

NUMBER	NUMBER TERM	COMPONENTS	LITERAL TRANSLATION
1	semal	se-*mal*	one-animate
2	riuwemal	riuwe-*mal*	two-animate
10	seig	se-*ig*	one-ten
12	seig me riuwemal	se-*ig* me riuwe-*mal*	one-ten and two-animate
20	riuweig	riuwe-*ig*	two-ten
22	riuweig me riuwemal	riuwe-*ig* me riuwe-*mal*	two-ten and two-animate
100	sebiugiuw	se-*biugiuw*	one-hundred

† **Source:** Adapted from Sohn (1975:80).
Note: In the third column, the classifiers are highlighted in *italics*.

4. Despite their obviously quantifying character, Benton (1968) categorizes only four of these classifiers (tentatively) as quantifiers, while he considers *–yáf/-yef* as a repeater. He does the same for other classifiers not considered here, such as *-cú* (strings of small fish) or *-sángá* (basketfuls of fish), arguing that not occurring with nouns having different phonological forms suffices to distinguish repeaters from quantifiers. However, on semantic grounds and in view of other quantifiers in this list, this distinction is not reasonable for a systematic analysis.

- *-yáf* /*-yef*: bundle of 10 (ripe) coconuts
- *-ccoc*: unit of 10 small pieces of breadfruit pudding
- *-fóc*: strings of 5 fish,
  bundles of 20 or more (or about 30) breadfruit,
  bunches of 20 coconuts
- *-sópw*: burdens of from 10 to 19 breadfruit (= half the quantity denoted by *-fóc*)
- *-ttit*: string of 10 breadfruit

These apparent changes in numerical value bear a remarkable similarity to the specific counting systems encountered in Polynesia, and we will now try to analyze these links in more detail.

3. LINKS BETWEEN NUMERAL CLASSIFIER AND SPECIFIC COUNTING SYSTEMS. Numeral classifier systems and specific counting systems with mixed bases share two important features. First, they treat different types of objects differently when being counted ("object specificity"). And second, at least some of them change—in one way or another—the numerical value of the adjoined numeral with regard to the absolute amount of single items ("multiplying function"). However, these shared features come in different versions: Micronesian languages typically require the use of any classifier for all numeral expressions except in serial counting; in Polynesian languages, only certain objects require specific treatment, while everything else is counted by plain numerals only. The objects counted specifically all belong—or rather belonged—to certain categories of natural products of subsistence that were both

TABLE 6. CLASSIFIERS WITH A MULTIPLYING FUNCTION IN SEVERAL MICRONESIAN LANGUAGES†

KIRIBATI		ULITHIAN		WOLEAIAN		CHUUKESE	
classifier	factor/object	classifier	factor/object	classifier	factor/object	classifier	factor/object
-bwii(-)	10 coconuts	-puluxu	school of fish, herd	-bwïs	some, group	-pwi	school, herd, group
		-yafe	bundle of round objects	**-yaf**	10 / 8‡ coconuts	-yáf/ -yef	10 coconuts
-ngaun	10(·10) coconuts	-ngo̊lo	10 coconuts	-ngaul	10(·10) coconuts		
		-fo̊co	bundle of breadfruit			-fóc	20 coconuts 5 fish ≥ 20 breadfruit
						-ttit	10 breadfruit
						-sópw	10–19 breadfruit
						-ccoc	10 small packages of breadfruit pudding

† **Sources:** Kiribati classifiers are from Bingham (1922:17), Harrison and Jackson (1984:70), and Silverman (1962); Ulithian from Sohn and Bender (1973:201, 231–45); Woleaian from Alkire (1970:9–10) and Sohn (1975); and Chuukese from Benton (1968), Dyen (1965), and Elbert (1947).
Notes: Cognate classifiers with blurred numerical value are shaded. Classifiers explicated in the text are highlighted boldfaced.

‡ On normal occasions, *yaf* refers to 10 coconuts, at funeral ceremonies to 8 (Alkire 1970).

culturally salient and abundant, such as fish, coconuts, the most prestigious starch food, and material for fabrics or thatch (Bender and Beller 2006, in press). On the other hand, while multiplying seems to be an essential feature of specific counting systems in Polynesian languages (Beller and Bender 2005; Bender and Beller 2006, in press), it is the exception rather than the rule in Micronesian languages.

3.1 SPECIFIC COUNTING IN MICRONESIAN LANGUAGES? In Micronesian languages, only a small number of classifiers could be identified that seem to have a multiplying effect: one in Ulithian, two each in Kiribati and Woleaian, and four or five in Chuukese (see table 6). Although this list is certainly not exhaustive, it does provide a good basis for comparing the two number systems. We will now analyze two of these classifiers in more detail: WOL *-yaf* and KIR *-ngaun* (see table 7).

WOL *-yaf*, being cognate to CHK *-yef/-yáf*, is used for counting globular things such as coconuts, chickens, eggs, stones, coins, and valuable shells (Alkire 1970:9–10; Fritz 1911:18; Harrison and Jackson 1984:70), and is translated as a "grouping (of ten)" (Alkire 1970:9). But does *-yaf* really change the numerical value of the adjoined numeral, as is the case for some specific terms in Polynesian languages? In Micronesian languages, power classifiers typically replace other classifiers when a power or a multiple of a power is referred to (e.g., Sohn 1975:81). The only exceptions are the power classifiers for ten, which may take different forms for certain objects (see Harrison and Jackson 1984). Woleaian, for instance, encompasses three different terms for ten: *(se)ngaul* with the restricted interpretation of 'ten groups', *(se)yaf* referring to tens of coconuts (or coins or shells), and *(se)ig* for tens of everything else (Harrison and Jackson 1984:70). This and the counting pattern up to 99 seem to indicate that *-yaf* merely replaces the more common power classifier for ten, *-ig*, when counting coconuts. In that case, coconuts would simply change their numeral classifier when the number switches from single coconuts to tens of coconuts. In addition, from 1,000 (*sangeras*) onwards, coconuts (whether in groupings of ten or not) are counted with the same power classifiers as all other items.

TABLE 7. PATTERNS OF CLASSIFIERS IN POWER TERMS (FOR COCONUTS AND OTHER OBJECTS) IN WOLEAIAN AND KIRIBATI†

POWER LEVEL	WOLEAIAN		KIRIBATI	
	all except coconuts	coconuts	most categories	coconuts
10^1	(se)**ig**	(se)yaf	(te)**ngaun**	(te)bwii(na)
10^2	(se)biugiuw	(se)ngaul / (se)**ig**	(te)bubua	(te)**ngaun**
10^3	(sa)ngeras	(sa)ngeras	(te)ngaa	(te)ngaa
…	…	…	…	…

† **Sources:** Woleaian power terms are taken from Alkire (1970) and Sohn (1975); Kiribati from Bingham (1922), Harrison and Jackson (1984:70), and Silverman (1962). **Note:** While *(te)bwii(na)* is used for all those objects that are countable with the general classifier *-ua*, *(te)ngaun* in its sense of 'ten (bundles of ten)' is used for coconuts only. Classifiers with changing numerical values (*ig* and *ngaun*) are highlighted.

However, for the amounts between 100 and 1,000, Alkire (1970:12) provides evidence for the contrary assumption. When reaching the absolute number of 100 coconuts, another specific term—namely *(se)ngaul*, referring to 'groups of ten'—is used instead of the general power classifier *(se)biugiuw*. Usually, the hundreds of coconuts were even referred to with *(se)ig*, the classifier indicating 10-general (table 7). The multiples of hundreds continued likewise: two of these tallies (i.e., 200 coconuts) were referred to as *riuweig* (20), three of these tallies (i.e., 300 coconuts) as *seliig* (30), and so on, until 1,000 was reached and denoted as *(sa)ngeras*. From here onwards, the number words refer back to the total number of nuts and no longer to their constituent groups of ten (Alkire 1970:12). In other words, at least for amounts between 10 and 1,000, coconuts were counted with a specific system in which the classifiers also had a multiplying function.

Interestingly, the specific counting for coconuts not only altered the power level of the number term, but also the numerical value of the affixed numerals when it referred to mature coconuts that were counted for ceremonial purposes during a funeral. In this case, *(se)yaf* actually referred to 8 instead of 10 pieces, *(se)ngaul* to 80 instead of 100 pieces, and so on (Alkire 1970:11–12). One of the reasons for this change might be that 4 (and partly its next multiple 8) is used as a formulistic number in ceremonial activities; an explicit instance documented in detail is divination (Alkire 1970:13–16).

A similar distinction is reported for KIR *-ngaun* (table 7). In Kiribati, 10 is glossed as *(te)ngaun* in all counting systems except the general (*-ua*) system for which *(te)bwiina* is used (Bingham 1922:16; Cowell 1951:27; Harrison and Jackson 1984:70; Silverman 1962:52). In the specific case of counting coconuts, otherwise part of this general system, *(te)ngaun* is still used, but its numerical value differs from the usual counting: "In numbering cocoanuts *teñaun* is always *one hundred*, probably because they are tied in bundles of tens, and *teñaun* may denote ten such bunches. In all other cases *tebubua* is one hundred. In all cases *teña* is a thousand, and *terebu*, ten thousand" (Bingham 1922:17). On structural and semantic grounds, Silverman therefore considers *-bwi(-)* and *-ngaun* to belong a type of classifier all its own (1962:54).

An even more rigorous system can be found for counting coconuts in Pohnpeian: not only *ngoul*—typically referring to ten, with coconuts referring to hundred—but all power terms up to *lik* (10^9) refer to units of 10 coconuts each (Rehg 1981:139).

In addition, some Micronesian languages such as Kiribati, Marshallese, or Puluwatese appear to have systems of pair counting. In Puluwatese, fish, breadfruit, and coconuts may be counted by twos (Elbert 1974:111). In Kiribati, it is even the serial counting numerals that are used for pair counting, but the set seems to be defective (Harrison and Jackson 1984:65, 75 n.9). These instances of pair counting indicate an even more systematic parallel to specific counting systems in Polynesia, but unfortunately we are lacking sufficient data to confirm this assumption.

However, even when this parallel is not taken into consideration, we still have evidence to conclude that in a few cases, numeral classifiers were used in a way that changed the numerical value of the adjoined numeral. This happened particularly when coconuts, breadfruit, or fish were involved—subsistence products of prime importance within the respective cultures. In other words, we were able to identify counting patterns typical for Polynesian number systems in Micronesian languages.

Will we, in turn, also find reflexes of numeral classifiers typical for Micronesian languages in Polynesian number systems?

3.2 CLASSIFIERS IN POLYNESIAN LANGUAGES? Although numeral classifiers are more strongly associated with contemporary Micronesian than Polynesian languages, the reverse appears to have been true in former times: So far, ten classifiers have been reconstructed for Proto-Polynesian, but only six for Proto-Micronesian (see table 8). Contrary to Micronesian number compounds in which the numeral is always prefixed to the classifier (N-C), this composition can vary in Polynesian languages and is accompanied by changes in numerical value and sometimes by changes in meaning (Clark 1999).

The common type in Polynesian languages is the C-N compound in which the classifier precedes the numeral. This type is documented for six Proto-Polynesian

TABLE 8. PROTO-POLYNESIAN AND PROTO-MICRONESIAN CLASSIFIERS IN COMPARISON[†]

Proto-Oceanic (POc)		Proto-Polynesian (PPn)			Proto-Micronesian (PMc)	
	etymology	[C-N]	[N-C]	used in counting …	[N-C]	used in counting …
***pua** [PAn *buáq]	fruit	***fua**	***fua**	fruits (part. coconuts); various other things	***ua**	general objects
	bunch		*fuhi	coconuts		
[PMP *qabus]	group, stalk(?)	*kau	*kau	general, various things		
[PAn *gem]	grasp		*kumi	fathoms		
***(n)dau** [PMP *d₂ahun]	leaf	***lau**		flat things; perhaps certain fish	***cau**	thin, flat objects
*manu(k) [PMP *manúk]	bird, creature				*manu	animate objects
[PMP *maCá]	eye	*mata		fish	Chk: *mas*	eyes, eye-related objects
	body	*tino		people; perhaps certain fish		
	back(?)	*tu'a		crustaceans; strands, layers, repetitions; heavens		
***(nga)pulu**	ten		***(hanga) fulu**	units of tens	***ngaulu**	units of tens
***Ratu(s)**	hundred		***rau**[‡]	units of hundreds	***ngaratu**	units of thousands
					*pwukua	units of hundreds

† **Sources:** Proto-Austronesian (PAn) and Proto–Malayo-Polynesian (PMP) forms are from Tryon (1995), Proto-Polynesian (PPn) from Clark (1999), Proto-Micronesian (PMc) and Proto-Oceanic (POc) from Jackson (1986:209), and Chuukese (Chk) from Benton (1968).
Notes: The classifier is prefixed to the numeral in "C-N" compounds, and suffixed in "N-C". Classifiers occurring in both language families are highlighted boldfaced. Cognate classifiers only found in contemporary languages are shaded.

‡ This correspondence is questionable (cf. second footnote in table 1).

classifiers, but in current usage seems to be restricted to Samoa and the Outliers. Classifiers allowing a C-N compound are often described as having a multiplying effect, as they seem to indicate a counting by groups of ten. However, this effect only occurs for the multiples of ten in an otherwise regular counting pattern. According to Clark (1999:199), it should therefore be termed "10 deletion" rather than multiplication.

In the N-C compound, the numeral precedes the classifier, sometimes linked to it with the ligature *-nga-; single units are often preceded by *te-. With regard to their formal properties, Clark (1999:200) places N-C classifiers together with terms for 10 (*fulu) or 100 (*rau)—a view shared by Harrison and Jackson (1984:64) for power classifiers in Micronesian languages. Unlike most of their Micronesian counterparts, however, Polynesian N-C classifiers have a consistent multiplying effect. Besides the power classifiers—with which they share a collective sense—only four Proto-Polynesian classifiers take this form (table 8), but their reflexes are more widely distributed, with clear cognates in Tongic and East Polynesian languages (Clark 1999:199–200; and see Bender and Beller 2006, in press).

Note that two classifiers can take either form, and that both their meaning and numerical value then change (Clark 1999): *fua in a C-N compound refers to fruit or various other things, while *fua in an N-C compound refers to 100 (pairs) of coconuts. Similarly, *kau in a C-N compound refers to various things, while *kau in an N-C compound refers to 20 (or rather 10 pairs) of specific types of objects.

In contemporary Polynesian languages, reflexes of Proto-Polynesian classifiers occur predominantly in the West. Let us therefore exemplify the syntactical and numerical characteristics of Polynesian classifiers with instances from Samoan and Tongan (for a description and analysis of the Rennellese system see Bender and Beller 2006; Christiansen 1975; Elbert 1988).

Samoan contains 15 different classifiers (Mosel and Hovdhaugen 1992), most of which explicitly distinguish between certain types of food (table 9 overleaf). When counting the respective objects, these classifiers are prefixed or suffixed to the respective numerals according to one of three different types (table 10 on page 395). The three classifiers of type 1 always precede the numeral (C-N) and are counted in a simple way.

Classifiers of type 2 change their syntactic order beyond ten (from N-C to C-N): When suffixed to a numeral from 2 to 9 or when prefixed to 100s, the resulting term refers to the number indicated by the numeral. However, when prefixed to the numerals from 2 to 9, the classifier indicates "tens of ..." (Mosel and Hovdhaugen 1992:246) or, in Clark's (1999:199) words, deletes 10. This process is complementary to the one in Micronesian languages, where power classifiers replace other classifiers (Harrison and Jackson 1984). From 100 onwards, however, the numerals indicate the proper power level, and therefore these number words can—contrary to the Micronesian ones—involve two classifiers: *'au selau* (100 bunches), for instance, contains both a qualifier (*'au* for coconuts) and a power classifier (*selau,* 100).

Finally, classifiers of type 3 only allow an N-C construction and systematically change the numerical value of the adjoined numeral, not by way of (syntactic) deletion or multiplication, but due to an inherent factor that defines a counting unit different from 1: *-aea* denotes 'score [of coconuts]' and thus multiplies the numeral by 20, *-'aui* denotes 'tens [of skipjack]', multiplying the numeral by 10, and *-oa* denotes 'pair [of coconuts or young pigs]' and therefore multiplies the numeral by 2. This corresponding change in numerical value bears a strong similarity to the Tongan specific counting systems.

Tongan contains six number markers—indicating two of the three grammatical numbers (dual and plural) and one of four categories (roughly glossed as people, animals, small/few objects, and big/large objects)—one of which (*kau*) is cognate to a numeral classifier. In counting, though, these number markers can be omitted. Instead, a general system of counting was supported by four distinct systems for specific objects (Bender and Beller in press). In these systems, the power terms *(hongo)fulu* and *(te)au* were partly replaced by distinct lexemes. Just as the power terms themselves, these lexemes reflect Proto-Polynesian classifiers of the N-C type: *(te)tula*, *(te)kau*, *(te)fua*, *(te)fuhi*, and *(te)kumi* (cf. table 8). With the exception of *(te)kumi* for counting fathoms, they all imply a numerical change, as they multiply the adjoined numeral by 2 and/or 20 (table 11 on page 395).

If we compare these distinct lexemes with the Samoan classifiers, we can identify two cognates—TON *fua* / SAM *fua* and TON *kau* / SAM *'au*—more or less referring to the same objects, namely to coconuts and yams respectively. Despite this striking similarity, however, the related SAM particles do not change the value of the affixed numeral.

TABLE 9. SYNTACTIC AND NUMERICAL CHARACTERISTICS OF NUMERAL CLASSIFIERS IN SAMOAN†

		Number terms (with 2 [*lua*] and 20 as example)		
Classfier	Category	N-C	C-N	Factor
TYPE 1				
sautua-	lines, rows, thicknesses, layers (-fold)	—	sautualua: sautua-2 = 2(fold)	—
tau-	things in bunches or clusters like coconuts	—	taulua: tau-2 = 2	—
tua-	rows, lines, layers, thicknesses (-fold)	—	tualua: tua-2 = 2(fold)	—
TYPE 2				
afī-	packages of small fish wrapped in leaves	—	afīlua: afī-2 = 20	—
pōtoi-	balls or lumps of food	—	pōtoilua: pōtoi-2 = 20	—
tu'e-	crabs, lobsters	—	tu'elua: tu'e-2 = 20	—
-'au-	bananas, yams, etc. (in bunches)	lua'au: 2-'au = 2	'aulua: 'au-2 = 20	—
-fua-	breadfruit, coconuts, fowls, some shellfish	luafua: 2-fua = 2	fualua: fua-2 = 20	—
-mata-	taro	luamata: 2-mata = 2	matalua: mata-2 = 20	—
-lau-	large fish (i.e., of a size that makes them suitable for cooking in leaf wrappings)	lualau: 2-lau = 2	laulua: lau-2 = 20	—
-'ofu-	items of food (except fish) wrapped in leaves	lua'ofu: 2-'ofu = 2	'ofulua: 'ofu-2 = 20	—
-tino-	skipjack	luatino: 2-tino = 2	tinolua: tino-2 = 20	—
TYPE 3				
-aea	coconuts	luāea: 2-aea = 40	—	· 20
-'aui	skipjack	lua'aui: 2-'aui = 20	—	· 10
-oa	coconuts, young pigs	luaoa: 2-oa = 4	—	· 2

† **Sources:** Adapted from Milner (1966) and Mosel and Hovdhaugen (1992:246–50).
Note: The classifier is suffixed to the numeral in "N-C" compounds, and prefixed in "C-N".

TABLE 10. TYPES OF NUMBER COMPOUNDS IN SAMOAN (WITH KIRIBATI CONSTRUCTIONS FOR COMPARISON)†

	Samoan				Kiribati	
POWER LEVEL	NUMERALS	TYPE 1	TYPE 2	TYPE 3	MOST	COCONUTS
10^1	N_1	$C\text{-}N_1$	(1) $N_1\text{-}C$ (2) —	N_1**-C_m**	$N_1\text{-}C_1$	$N_1\text{-}C_1$
10^2	N_1N_{10}	$C\text{-}N_{10}$	**$C\text{-}N_1$**‡	(N_{10}**-C_m**)	$N_1\text{-}C_{10a}$	N_1**-C_{10b}**
10^3	N_1N_{100}	?	$C\text{-}N_{100}$ ($C\text{-}N_1N_{100}$)		$N_1\text{-}C_{100}$	N_1**-C_{10a}**

† **Sources:** Abstracted from Samoan instances provided by Mosel and Hovdhaugen (1992:246–50) and Milner (1966) and from Kiribati instances provided by Bingham (1922), Harrison and Jackson (1984:70), and Silverman (1962).
Abbreviations: C, classifier; C_m, multiplying classifier; N, numeral; subscribed numbers refer to the power level, thus: N_1, single numerals; N_{10}, tens; N_{100}, hundreds; C_1, classifier for single objects; C_{10}, for tens; and C_{100}, for hundreds (with "a" and "b" indicating that different classifiers are used).
Note: Constructions and components implying a numerical change are highlighted boldfaced.

‡ For some objects, the number word for 10 is composed with the numeral for 10 ($C\text{-}N_{10}$), but multiples of 10 are nevertheless denoted with $C\text{-}N_1$.

TABLE 11. CLASSIFIERS IN TONGAN SPECIFIC COUNTING SYSTEMS†

		GENERAL	SUGAR CANE	COCONUTS	PIECES OF YAMS
POWER LEVEL	NO.	N -C	N -C	N -C	N -C
10^0	1	taha			
	2	ua	taha (nga'ahoa)	(taua'i … 'e) taha	(taua'i … 'e) taha
	4	fā	ua (nga'ahoa)	(taua'i … 'e) ua	(taua'i … 'e) ua
10^1	10	hongo -fulu	… …	…	…
	20	uo -fulu	te -tula	te -kau	te -kau
	40	fāngo -fulu	uango -tula	uanga -kau	uanga -kau
10^2	100	**te -au**	… …	… …	… …
	200	uange -au	**te -au**	te -fua	te -fuhi
	400	fānge -au	uange -au	uo -fua	uango -fuhi
10^3	1,000	(taha) afe	… …	… …	… …
	2,000	ua afe	(taha) afe	**te -au**	**te -au**
	4,000	fā afe	ua afe	uange -au	uange -au
…		… …	… …	… …	… …

† **Source:** Adapted from Bender and Beller (in press).
Notes: The power classifier common to all counting systems, *(te)au*, is highlighted boldfaced. Numerals composed with power terms not reflecting a classifier are shaded.

(1) SAMOAN
e lua-fua niu
NPT 2 CLF for coconuts coconut (NPT, number particle)
'2 coconuts'

(2) TONGAN
niu 'e uo- fua
coconut NPT 2 10-score [of coconuts], i.e., 200
'400 coconuts'

The Samoan expression (1) refers to just 2 coconuts, whereas the corresponding particle in Tongan (2) multiplies this amount by 10-score (200), thus yielding 400 coconuts. It is only when numeral and classifier change their position (as in *fua-lua*) in Samoan that a numerical change occurs (from 2 to 20), but as Clark (1999) has argued, this would be a ten-deletion rather than a multiplication. Nevertheless, a process similar to the Tongan multiplication can also be observed in Samoan, and remarkably for the same object again:

(3) SAMOAN
e lua- aea
NPT 2 CLF for coconuts [indicating a score]
'40 coconuts'

As these examples show, specific counting systems are composed in both languages according to the same principles, albeit with significant differences in details: They are uniformly composed from classifiers that define a new counting unit, but the choice of classifiers and counting units diverges, even in related languages.

4. CONCLUSION. To summarize, Polynesian and Micronesian languages inherited similar number systems from Proto-Oceanic: these number systems were decimal and contained numerals for 1 to 10 and 100 that reflected common linguistic roots. Most of these languages had also developed—largely independently of each other (see also Harrison and Jackson 1984:73)—numerals for high numbers (up to 10^{10}). In addition to these general systems, in pre-European times, a wide range of Polynesian languages applied specific counting systems with apparent mixed bases that were restricted to certain objects. In principal, these systems were still decimal, often employing the very same numerals, but operating with counting units different from 1; the most popular counting units were pairs, groups of four or ten, and scores (Bender and Beller 2006). Micronesian languages, on the other hand, elaborated their systems of numeral classifiers, required when counting different categories of objects, which extended to more than one hundred distinctions in some languages (e.g., Benton 1968; Harrison and Jackson 1984).

A detailed comparison of Polynesian and Micronesian languages reveals common patterns beyond their general number systems. Classifiers have a long tradition not only in Micronesian but also in Polynesian languages (Clark 1999). Four classifiers in both language families even have common roots in Proto-Oceanic, and at least one Proto-Polynesian classifier has cognates in contemporary Micronesian languages (cf.

table 8). There is also evidence for the fact that specific counting systems were, in turn, applied in some Micronesian languages (cf. table 6). And finally, both language families shared, at least to a certain degree, a concern for several objects to which these specific counting systems referred.

While most numeral classifiers in Micronesian languages did not change the numerical value of the adjoined numeral, a few did involve such specific counting systems. On the other hand, at least one numeral classifier appeared in any given specific counting system, and this raises the question as to how these two number systems are linked. In the concluding section, we will therefore address the role of numeral classifiers for specific counting systems. As we will see, numeral classifiers can be involved to various degrees, creating different types of counting systems. These need to be compared with respect to superficial and structural similarities in order to answer our final question of how these systems and their peculiar features may have evolved.

4.1 THE ROLE OF NUMERAL CLASSIFIERS FOR SPECIFIC COUNTING SYSTEMS. In Micronesian languages, classifiers are suffixed to numerals from 1 to 9 and typically replaced by numerals for the base and its powers. In other words, classifiers and powers alike are themselves counted. Some scholars (e.g., Benton 1968; Clark 1999; Harrison and Jackson 1984) argue therefore that classifiers (including power classifiers) should be reconceptualized as *countable bases*. Although we agree with their arguments, we will use the term *counting unit* instead, as we are also concerned with the numerical notions of these terms (cf. fn. 3).

Most classifiers, especially the repeaters and qualifiers, simply *classify* the objects of reference. Quantifiers also introduce a new—though in most cases blurred—counting unit (such as group or bunch). The power classifiers, on the other hand, do not classify, but *multiply*. They indicate a precise value—either the base of the number system or one of its powers—that serves as a factor for the adjoined numeral. As power classifiers replace other classifiers, they typically indicate the new counting unit independently of the object concerned. A few classifiers, however, adopt both a classifying and a multiplying function: They have a precise value and are restricted to certain objects indicating, for instance, 'tens of coconuts'.

In Polynesian specific counting systems, numeral classifiers play diverging roles. In Samoan (and Rennellese), which contain the largest set of classifiers, the Micronesian pattern emerges most clearly.[5] Most of the 15 classifiers in Samoan are used only in their classifying function. Nine also have the effect called "ten deletion" (Clark 1999) in which the classifier replaces the power classifier (contrary to Micronesian in which the power classifier replaces other classifiers). Only three classifiers in Samoan also have a clear multiplying function, and these classifiers are then counted in the same way as power classifiers (cf. table 8).

In Tongan, on the other hand, the usage of classifiers is more homogenous. In addition to the power terms, five classifiers can be identified (cf. table 11), all derived from Proto-

5. Due to their location between Polynesia and Micronesia, the languages of the Polynesian Outliers Nukuoro and Kapingamarangi might provide particularly valuable insights into this topic. But apart from the fact that Nukuoro contains the largest number system in Polynesia, we have not much data about these systems and therefore have to leave this for future research.

Polynesian roots. Although their etymology hints toward the specific objects counted, none of them has a classifying function only (with the debatable exception of *-kumi* for counting fathoms). Instead, they are used exclusively in the specific counting systems, where they are suffixed to the numeral in a way similar to the power terms and then counted in the same way. They are employed to define or count new counting units and thereby adopt both the classifying and the multiplying function. For instance, when counting coconuts, *(te)kau* defines a new counting unit as the score, which is then counted (with an N_1-C_{20} construction) until ten such units are reached. The power classifier for ten is replaced here—and counted further—with *(te)fua*, indicating 10 scores of coconuts (i.e., ten score-units are labeled with N_1C_{200} instead of N_1N_{10}-C_{20}—see table 11).

The type of specific counting systems with the least involvement of classifiers can be identified in Eastern Polynesian languages such as Tahitian. Here, we find some of the most abstract specific counting systems. They are still restricted to certain objects, but share reflexes of one classifier only, *(te)kau. As this term is used to denote 20 in most Polynesian languages (except in Hawaiian, where *ka'au* refers to 40), it gave rise to ample speculation on the base of the number system in early periods of language description (e.g., Best 1906; Large 1902; Smith 1902; Tregear 1969:503–4). Derived from PPN *(te)kau, meaning 'group' (Clark 1999), this term may originally have functioned as a blurred counting unit only (as in Samoan) and then developed into a classifier with a multiplying function. Interestingly, this most prominent Polynesian classifier seems to be completely lacking in Micronesian languages.

However, the specific counting systems do not merely differ with regard to the involvement of the classifiers. Although all of them enabled different modes of counting, each did so in a different way. More precisely, we do not find congruence in *any* of their characteristic components: counting unit, classifier, or object of reference. From our survey of Polynesian and Micronesian languages, we were able to extract counting units defined by one or several of the factors 2, 4, 5, 8, 10, 12, 20, and 22, with the pair being the most popular (Bender and Beller 2006). In addition, even though often referring to the same objects, the classifiers that are linked to this multiplication function do differ. For instance, coconuts are specifically counted with a reflex of POC *pua in Tongan (i.e., *fua*, referring to 10 counting units of 20 each), but not in Samoan or in Micronesian languages, where it either refers to single coconuts or to a general category. The classifiers adopted instead in Samoan are *oa* (counting unit 2) and *aea* (counting unit 20), whereas Woleaian uses *yaf* and Kiribati *bwii* (both referring to counting unit 10). And finally, even with regard to the objects counted specifically, no consistent picture emerges, at least not on the level of concrete objects. Coconuts, for instance, are of special concern in most but not all languages (e.g., they are not documented for Hawaiian, Mangarevan, or Marquesan).

And yet, on a more abstract level, these systems share two characteristics: All of them are restricted to specific objects that belong to a small category with common features ("object specificity"), and in some cases, the process of counting was enhanced by counting them in larger counting units, thus changing the numerical value of the adjoined numeral ("multiplication function"). How can we reconcile this consistent pattern with the differences in terms of detail? This leads us to our final question:

How could these specific counting systems have evolved—or, most likely, why were they developed?

4.2 THE ORIGIN OF SPECIFIC COUNTING SYSTEMS. In Polynesian and Micronesian languages, the most limited number systems generally cooccur with largely reduced classifier categories and/or specific counting systems (Bender and Beller 2006; Harrison and Jackson 1984:74). When addressing the question of how these specific counting systems developed, we therefore also need to consider the large extent of many of these number systems.

For the extension of the Micronesian number systems beyond their original numerals of up to 10^3, it was sufficient, as Harrison and Jackson (1984:73–74) argue, to have numeral classifiers ("countable bases"), particularly quantifiers, as a grammatical category. Power classifiers initiate a mathematical series of increasing powers, but apart from yielding a mathematical interpretation only, they share all properties with quantifiers, particularly in that they themselves are counted. Consequently, other quantifiers can also be incorporated into the power series if the counting unit to which they refer is (re)defined as a power of the base. By incorporating new classifiers, the system is extended.

The Polynesian and Micronesian instances reviewed in this article show that a number system can be extended in at least two dimensions: classifiers can be added "in breadth" in order to differentiate ways of counting for different objects; classifiers can also be added at the end of a power series ("in length"), thereby extending the range of counting. A large number of classifiers is the result of the first extension, and high numerals are the result of the second. Combining the two creates a third, and for our purpose the most interesting, variant: if classifiers are incorporated not on the basic, but on a higher level, a new series of counting for the respective objects is instantiated and extended, based on a higher counting unit ("base substitution"). This creates a specific counting system and enables an acceleration of counting.

Micronesian and Polynesian languages alike adopted this principle of establishing specific counting systems with numeral classifiers that define a higher counting unit. This indicates that both the principle and its components may have existed in Proto-Oceanic. The way in which these specific counting systems were constructed, however, differed in most of the languages. The classifiers and counting units that they picked for their specific objects of concern seem to be largely arbitrary. The extent to which they applied specific counting systems, however, and the range of objects for which they did so, most likely resulted from cultural adaptations to various requirements or constraints, such as the resources available in the respective environment and salient in the respective culture, or the size of the population.

Our analysis encourages us to assume that one of the main reasons for applying specific counting systems was to extend the number system to large numbers. The high numerals in many Micronesian and Polynesian languages have often raised doubts among scholars about the genuineness of their numerical value (e.g., Clark 1999:197; Elbert 1988:187; Elbert and Pukui 1979:160–61). However, as high numerals are a recurrent pattern across two language groups, attesting a widespread interest in high numbers and possibly even mathematics, we should take the numerical interpretation seriously.

At least in Polynesia, this interest might have been motivated by socioeconomic reasons (Beller and Bender 2005; Bender and Beller 2006, in press). In general, both the extent of the number systems and the number of counting modes increases with increased stratification. A concern with collecting and redistributing resources was particularly strong in islands with powerful chiefs or kings, such as Tonga or Tahiti, and obviously less pronounced in societies with less centralized political forces or small communities, such as Māori (e.g., Kirch 1984, 1986). The category of resources frequently redistributed overlaps to a considerable extent with the category of objects specifically counted, consisting of subsistence products that were both culturally significant and abundant. On certain occasions, these objects were required in large amounts, for instance, when paying tribute to the chiefs, when supplying large numbers of people during funerals or war, when providing the material needed for traditional fabrics, or when accumulating wealth for competitive givings (e.g., Bender and Beller in press; Elbert 1988; Martin 1991:115). When redistribution was involved, it was *calculation* rather than counting that was required (Beller and Bender 2005), and when ceremonial purposes or prestige were involved, this had to be done very carefully (Christiansen 1975; Elbert 1988; Hughes 1982:254).

Keeping track of the flow of objects was therefore particularly important, but the respective calculations are difficult in the absence of external representations (Nickerson 1988; Zhang and Norman 1995). Indigenous systems of number notation are documented for Faraulep and Puluwat (Damm 1938:212–16; Damm and Sarfert 1935), and in some Polynesian cultures knotted cords might have served as mnemonics for tallies and arithmetic (Barthel 1971; Best 1921).[6] However, at least the Micronesian instances were of recent origin (Damm 1938:213), and for the Polynesian, a systematic application is more than questionable (cf. Best 1921:71). In this context, specific counting systems could have served a second practical purpose, namely to reduce the cognitive load of the calculators by extracting a certain factor—actually the same factor inherent in the counting unit. Larger absolute numbers were thus reached faster and with less effort (Beller and Bender 2005; Bender and Beller in press).

The same might not hold for Micronesia, although even there, high numbers gained importance with specific resources. On Lamotrek and Fais in the Central Carolines, for instance, large amounts of *til* fish were regularly distributed among the villages according to fixed proportions (Krämer 1937:336–37, 412), and on Woleai, an instance of redistributing more than 12,000 coconuts locally during a funeral is documented (Alkire 1970). Supraisland ties, linking islands like Woleai with Yap, may have required similar amounts for shares and tributes (Alkire 1970). But even if we did not accept practical reasons for Micronesia, we would underline Harrison and Jackson's

6. Knots are also documented for Micronesia, predominantly as knotted palm leaves used in divination (e.g., Alkire 1970). The correspondence of PMC *pwukua, referring to 'units of hundreds', with *pwukua 'knee, node, joint' also hints toward an early Micronesian custom of enumerating knots in a rope (Jackson 1986:209). These indications of an external representation of numbers, the possible similarity between Micronesian and Polynesian knot-calculation, and perhaps even their use in navigation all deserve more thorough research.

conclusion that it is "not … inconceivable that an abstract mathematics with linguistic means of representing quantities of such magnitude or beyond could have developed in traditional Oceanic societies" (1984:61). An interest in high numbers can also have several other reasons, such as aesthetic purposes or an interest in pure mathematics (Ascher 1998), their usage in divination (Alkire 1970), or just for recreational games, as is reported for Tahiti (Henry 1928:323). The prime justification for assessing high numerals as real number words is provided by the speakers of a language themselves. If they agree upon the fact that each apparent power term is a ten-multiple of the immediately preceding one (cf. Harrison and Jackson 1984:61, 67), then what we have is *by definition* a series of numerals that constitutes an extensive number system. Nobody can be justified in questioning this only on the grounds of not being aware of any practical use for these larger numbers.

We have no doubt that the indigenous interest in high numbers in Polynesia and Micronesia inspired people to systematically incorporate numeral classifiers into an originally regular decimal system. In doing this, they not only developed innovative ways of counting, but also designed an efficient strategy to cope with the cognitive difficulties of accurately calculating in the absence of a notation system.

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