On numeral complexity in hunter-gatherer languages

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Abstract

Numerals vary extensively across the world's languages, ranging from no precise numeral terms to practically infinite limits. Particularly of interest is the category of "small" or low-limit numeral systems; these are often associated with hunter-gatherer groups, but this connection has not yet been demonstrated by a systematic study. Here we present the results of a wide-scale survey of hunter-gatherer numerals. We compare these to agriculturalist languages in the same regions, and consider them against the broader typological backdrop of contemporary numeral systems in the world's languages. We find that correlations with subsistence pattern are relatively weak, but that numeral trends are clearly areal.

Keywords: borrowing, hunter-gatherers, linguistic area, number systems, numerals

1. Introduction

Numerals are intriguing as a linguistic category: they are lexical elements on the one hand, but on the other they are effectively grammatical in that they may involve a generative system to derive higher values, and they interact with grammatical systems of quantification. Numeral systems are particularly noteworthy for their considerable crosslinguistic variation, such that languages may range from having no precise numeral terms at all to having systems whose limits are practically infinite. As Andersen (2005: 26) points out, numerals are thus a "liminal" linguistic category that is subject to cultural elaboration.

Recent work has called attention to this variation among numeral systems, particularly with reference to systems having very low limits (for example, see Evans & Levinson 2009, D. Everett 2005, Hammarström 2010). This linguistic variation has also been shown to have fascinating cognitive parallels, such that

the development of numeral systems has been linked to the development of specific cognitive skills relating to the manipulation of precise quantities (e.g., P. Gordon 2004, Pica et al. 2004, Spaepen et al. 2011).

The processes of elaboration and change in numeral systems may be rapid, and numerals are often restructured via contact and innovation (see Comrie 2005, cf. Blažek 1999: 325). Systems may reflect these processes of elaboration over time, comparable to “the history of an old building, [seen] from the contrasting styles of its pieces, from the foundations up” (Hurford 1987: 83). These traces are more likely to be detectable in systems that have been elaborated relatively recently (see, e.g., the discussion of Nadahup numerals in Epps 2006).

It is highly likely that the variable development of numeral systems in the world’s languages has been shaped in part by cultural factors – although we note that the robustness of universals in numeral composition (see, e.g., Greenberg 1978, Hurford 1987, 2007) provides evidence that cognitive processes also play a role. However, defining the relevant cultural factors is still largely a matter of conjecture. In a few cases, specific cultural practices have been convincingly linked to particular numeral strategies; for example, conventionalized yam-counting practices in Southern New Guinea have almost certainly fostered the development of a senary (base-six) numeral system in a number of these languages (Evans 2009, Hammarström 2009, Plank 2009).

More generally, the elaboration of overall complexity in numeral systems – i.e., the development from highly restricted to generative systems that can name precise quantities into the tens, hundreds, or thousands – is motivated (at least in part) by social and cultural practices that encourage counting and/or keeping track of precise quantities. Many authors have suggested that these practices correspond to aspects of social complexity, such as the scale and scope of regional exchange (Winter 1999) and/or division of labor (Greenberg 1978: 291). However, the most frequently proposed correlate to numeral complexity is subsistence pattern – that is, whether a group relies primarily on hunting, gathering, and/or fishing, as opposed to farming and/or pastoralism, for primary food sources (Stampe 1976: 596, Heine 1997: 24, Winter 1999: 43, Hammarström 2008). In particular, small numeral systems have been widely associated with hunter-gatherers, who are presumed to have less need for numerals; in fact, hunter-gatherer numeral systems are typified as small and simple, as by Dixon (1980: 107–108) when discussing Australia. This generalization is no doubt linked to the widespread assumption that hunter-gatherers share a predictable package of social traits – of which some or all may be implicated in numerosity – including egalitarian social structure, low population size/density, high mobility, a relatively simple technological toolkit, a direct-exchange economy, etc. However, hunter-gatherer societies in fact exhibit considerable diversity along these parameters, which are all best understood as gradient (see Panter-Brick

et al. 2001, Kelly 1995, Bowers 2010: 666). Accordingly, any assumption that the numeral systems of hunter-gatherers are uniformly small and simple, or even broadly similar, calls for fine-grained investigation.

If hunter-gatherer languages share characteristics that set them apart from languages spoken by agriculturally oriented and/or urban populations, then this fact has important implications for our understanding of numerosity in human language (cf. Comrie 1999). Because the period in which humans have been practicing agriculture and pastoralism represents only a small fraction of human history, the vast majority of languages spoken over time have been hunter-gatherer languages. Although we cannot assume that contemporary hunter-gatherers are directly comparable to those that lived in prehistoric times, they are obviously the closest representatives available; yet hunter-gatherer languages have been only minimally represented in typological studies of numeral systems. In some cases groups of hunter-gatherers have been intentionally excluded due to assumptions that many of them have no true numerals at all (e.g., Hanke 2005, who does not include Australian languages for this reason); in other cases, their languages are little represented simply because they constitute a small fraction of the contemporary languages of the world (and moreover are often poorly documented), so necessarily make up only a small part of even a broad sample (e.g., Comrie 2011, Greenberg 1978).

In this article, we investigate the characteristics of hunter-gatherer numeral systems, and consider these against the broader typological backdrop of contemporary numeral systems in the world's languages. Our survey focuses on the numeral systems of 193 languages spoken by peoples with a strong hunting-gathering orientation, located on four continents: North America (primarily California and the Great Basin), South America, Australia, and Africa. These are areas in which many hunter-gatherer groups are present, and where it is possible to systematically investigate variation in numeral system complexity across and within these and other groups. For comparative purposes, we also include seven hunter-gatherer languages spoken in Asia. Finally, we compare the trends observed among these languages to those exhibited by the languages of their agriculturalist, semi-agriculturalist, and/or pastoralist neighbors (with the exception of Australia, which has no native agriculture), drawing from our survey of 204 of these non-hunter-gatherer languages and from the results of other typological surveys of numerals (Greenberg 1978, Hanke 2005, Hammarström 2010, Comrie 2011).

We focus on the following questions in our investigation:

- (i) How does numeral complexity pattern across and within the hunter-gatherer languages in the regions investigated (principally the four focal areas)? Specifically, we consider the upper limits of native systems, limits to sequences of underived native ("atomic") numeral lexical items, and the values and multiplicity of bases.

- (ii) Do we find evidence that numeral complexity correlates with subsistence pattern and/or other sociocultural parameters? To what extent can we generalize across hunter-gatherer numeral systems? Where systems are small, are they relatively uniform? How much diversity do they allow in the possibilities for numeral formation?
- (iii) What processes can be identified that indicate the elaboration and development of numeral systems over time, and are these more or less evident in hunter-gatherer languages?

As the following discussion will elaborate, we find that languages spoken by hunting-gathering peoples exhibit considerable variation in their numeral systems, and that subsistence practice is not in itself a predictor of numeral system type. However, there does appear to be at least some hint of a correlation between numeral complexity and subsistence pattern, but this is regionally dependent. The clearest correlations relating to numeral system trends are areal.

2. Methodological considerations

Our survey focuses on the hunter-gatherer languages spoken within the four designated focal regions (Australia, North America, South America, and Africa). We have included as many of these languages as possible within the constraints of the available data (many are not well described). The total number of hunter-gatherer languages sampled (193) represents approximately one-third of the total number of hunter-gatherer languages spoken in the world today, which is itself only a small fraction of the number of languages spoken by hunter-gatherers throughout human prehistory (Lee & Daly (eds.) 1999).

Across the four regions, the languages are distributed as follows. For Australia, we sampled 122 languages (including several closely related varieties) from 7 families, concentrated in the northwest of the country but extending into the south and east where data were available. All groups are hunter-gatherers; Australia has no native agriculture. For California and the Great Basin in North America, our sample includes 35 languages from hunting-gathering groups, corresponding to 10 language families. The South American sample consists of 19 hunting-gathering-focused language groups from 9 families, with a concentration in the northwest Amazon but extending throughout the continent where data were available (note that very few South American groups are “pure” hunter-gatherers; see below). The African set is composed of 17 hunter-gatherer languages from 7 families. In addition, as noted above, we include seven other languages spoken by hunter-gatherers in Northeast and Southeast Asia, viz. Jahai (Aslian), Semelai (Aslian), Agta (Austronesian), Ainu (isolate), Ket (Yeniseian), Kolyma Yukaghir (Yukaghir), and Nivkh (isolate).

In order to contextualize the hunter-gatherer languages surveyed within their regional contexts, we included the following non-hunter-gatherer languages in our survey. From California, the Great Basin, and the U.S. Southwest, we sampled an additional 17 languages spoken by agriculturalists and 5 languages spoken by peoples practicing a more mixed subsistence (e.g., agriculture and hunting-gathering in different parts of the year), corresponding to 5 language families (of which 2 are also represented by hunter-gatherers in our sample). From South America – where the majority of groups practice some agriculture – we included 105 languages from groups we classified as primarily agricultural, and 62 languages from groups practicing more mixed subsistence (e.g., seasonal Je peoples); these languages contributed an additional 29 language families to our sample, plus several more shared with the hunter-gatherers. Finally, we included 13 agriculturalist/pastoralist and 2 mixed-subsistence languages from Africa, representing 4 families (of which 3 are also represented among the hunter-gatherers),¹ spoken in the same general regions as the hunter-gatherer languages surveyed.

Because our focus is on hunter-gatherer languages, which are relatively few in today's world, this survey does not contain a balanced sample. We have not controlled systematically for language family, since this would drastically reduce our sample size, and since both numeral systems and subsistence strategies can change fairly rapidly. Although this approach limits the power of our generalizations, it allows us to bring to wider attention a group of languages that has been largely ignored in other typological studies. Because of the small and unbalanced sample numbers, we have focused on qualitative generalizations and tendencies that arise from the data, rather than conduct an extensive statistical survey.

Our primary focus is on languages spoken by peoples with a hunting-gathering orientation, but subsistence practices are in many cases complex, and frequently do not lend themselves to clear-cut categorization. Moreover, subsistence patterns vary considerably across and to some extent within case study regions. In Australia, indigenous groups are exclusively hunter-gatherers. In South America, on the other hand, the distinction between hunter-gatherer and agriculturalist is far from clear-cut, with most groups engaging in both foraging and farming to varying degrees, while those with a clear foraging emphasis are relatively few (and may still engage in close management of non-domesticated

1. Four of these African agriculturalist languages are in fact also spoken by hunter-gatherer Pygmy groups. The degree of dialectal separation between these groups and their agriculturalist neighbors varies (Bahuchet forthcoming), but our sources describe these languages as spoken by the agriculturalists without giving information on how they are spoken by hunter-gatherers. Because we only have data from the agriculturalist varieties of these languages, we have included them here with the agriculturalist sample.

resources; see, e.g., Balée 1992, Posey 1984, Politis 2007, Rival 2006: S82–83, Zent & Zent 2004). Moreover, detailed information about past subsistence practices is lacking for many of these groups, and for some (e.g., Yanomami, see Early & Peters 2000) reliance on agriculture has increased together with proximity to the national society and availability of metal tools; for others, a hunting-gathering focus may have emerged as a survival strategy following European contact (as, for example, Balée 1999 argues for the Tupí-Guaraní Guajá). In North America and Africa, similarly, various groups have altered their relative dependence on foraging or farming over time. Other parameters also vary among hunting-gathering peoples, such as their dependence on aquatic resources (e.g., the Seri people of northern Mexico, who extract most of their protein from the sea), which may be linked in turn to social patterns like mobility. Mobility patterns vary widely; for instance, in North America mobility was high in Great Basin groups, while some populations in southern California, such as speakers of Chumashan languages, were largely sedentary. Similarly, in Africa, the Aka, Baka, and Mbuti groups are semi-nomadic, while many other Pygmy groups live in settled villages (Bahuchet forthcoming).

Accordingly, we characterize subsistence orientation here with reference to a set of criteria. These include the actual proportion of wild/domesticated food consumed, the amount of time spent on foraging/farming related activities, and the cultural importance of these activities, relative to other groups in the wider region.² More traditional subsistence practices are prioritized where there is evidence for substantial recent change.

A further consideration within our sample of hunter-gatherer languages is language shift. In some parts of the world, imbalanced social relations between hunter-gatherers and their neighbors have caused the hunter-gatherers to abandon their original languages and adopt those of their neighbors (see, e.g., Spielmann & Eder 1994: 307). In some cases, these shifts are quite old, such that the hunter-gatherers now speak their own variety of the more widespread language. Shifts of this kind are known to have occurred in Southeast Asia, where the Agta peoples have adopted Austronesian languages (Blust 1976, Reid 1987), and the Aslian groups apparently switched to Mon-Khmer at some point in the relatively distant past (Junker 2002: 151). These shifts have also been argued to have occurred in Africa; for example, the Bantu and Ubangian languages spoken by the Aka and Baka Pygmies are apparently the result of past shifts (Bahuchet 1993, forthcoming), though see Blench (1999) for an alternative view. Many of these languages are now unintelligible with those of the agriculturalists, and there is considerable variation among their numeral systems. In the remainder of our sample, no shifts to agriculturalist languages are doc-

2. For most of these groups, only approximate estimates are available.

umented for the Australian, North American, or South American case study regions (where it is more common to find groups that maintain their languages and shift their subsistence practices, in some cases from agriculture to foraging).³

In surveying numeral systems, we follow the working definition of numerals as given in Hammarström (2010: 10): “spoken, normed expressions that are used to denote the exact number of objects for an open class of objects in an open class of situations with the whole speech community in question.”⁴ Accordingly, we do not include auxiliary or secondary counting systems, which are restricted to particular entities or social situations, although we note that these represent an intriguing additional facet of numeral complexity (and may in some cases represent initial stages in the development of new complexity in numeral systems as defined here). For example, some Australian languages have birth-order names, and other languages have counting terms used only for entities like cattle, e.g., Gurindji (Pama-Nyungan), or coconuts (Wuvulu, an Austronesian language of New Guinea; Hafford 1999: 37–39, cited in Hammarström 2010: 12). A few South American languages – e.g., Dâw (Nadahup; Martins 2004) – have tally systems (often finger-based) involving imprecise quantitative terms, such as ‘even’ and ‘odd’. We also do not consider discourse-based variation in numeral manipulation (see Reed & Lave 1979). On the other hand, we do take this definition to include terms that are semi-conventionalized but not completely fixed, as long as they correspond to precise values (both because this meets our criteria for numerals and because such variation is likely to be overlooked in grammars and dictionaries); examples include the terms for 6 to 10 in the South American languages Hup (Nadahup) and Iquito (Zaparoan); e.g., 6 = ‘one finger stands up’, ‘add another finger’, etc.⁵

3. In California, language shift toward Yokuts was apparently under way in some communities of speakers of Western Mono and Tübatulabal (cut short by a more general shift to English), but all of the groups concerned are hunter-gatherers. In South America, there are ethnohistorical accounts of hunter-gatherer groups merging with agriculturalist neighbors (e.g., Nadahup bands being absorbed into Arawak or Tukanoan groups as low-ranked clans), but these do not involve entire speech communities and are as yet unverified.

4. For this reason, we include only one of the two numeral systems that occur in Seri, a hunter-gatherer language of northern Mexico. As Moser & Marlett (2005: 2) report, “since the last century, it is reported that in Seri there are two numeral systems in series, including one that is used only for counting. Currently, this series is known, although it is not used frequently and is only used when one is counting” (our translation from Spanish). It is possible that this auxiliary counting system, which is much more restricted, represents an older numeral system that has been partially superseded by the more complex one. We include only the more complex system in our figures, but note the properties of the simpler system in footnotes.

5. As an anonymous reviewer points out, subitizing (i.e., the rapid reckoning of the quantity of items within a space; see Kaufman et al. 1949, Gross 2011) may be a relevant aspect of numerosity as it occurs in some of the language groups considered in this article. Since subitizing limits are usually around 4 or 5, subitizing may be a more relevant cognitive process

This survey focuses on cardinal numerals, and considers their limits, bases used, and historical sources (etymological or loan). Data were obtained from a wide range of published and unpublished sources.⁶ These are of varying quality and thoroughness, so figures used in this study represent attested/known numeral values only. Languages were excluded where significant gaps in the recording were judged to exist, such that an accurate assessment of the system's complexity could not be made. A list of languages and sources used is given in the Appendix.

3. Extent and complexity of numeral systems

3.1. *Languages with vague or ambiguous numeral terms*

A number of the world's languages have been described as having no “basic” numeral terms at all; that is, terms whose primary meaning corresponds to a precise numeral quantity. Such anumerical systems are very rare, as discussed by Hammarström (2010: 20). An oft-cited example is Pirahã (Mura family, South America; D. Everett 2005: 623):

(1)	Pirahã	
	<i>hói</i>	‘small size/amount’ (or ‘one’)
	<i>hoí</i>	‘larger size/amount’ (or ‘two’)
	<i>bá a gi so</i>	‘cause to come together, many’

Other languages are reported to have basic terms for ‘one’ and/or ‘two’, but allow vague or imprecise readings of terms beyond these (‘some’, ‘many’, ‘a few’). Both exact and approximate uses exist for some terms; i.e., they may be interpreted as either having a precise value or a vague reference (compare English *a couple*, which can mean ‘exactly two’ or ‘a few’, but not ‘exactly four’). This fact often leads to dissent about whether such terms are true numerals – see, for example, the discussions concerning Pirahã (D. Everett 2005, Frank et al. 2008, Nevins et al. 2009: 387), Jarawara (Dixon 2004b: 179–180, C. Everett forthcoming), and Warlpiri (Hale 1975, Bower & Zentz 2011). It can be very difficult to establish which meaning is “primary”, even in an experimental context; when drawing from written sources, determining whether the exact or approximate meaning is primary – or sometimes whether an approximate meaning even exists – is usually impossible. Accordingly, for all languages in

to small numeral systems than enumeration or counting. Harris (1987) provides anecdotal information about subitizing strategies among Australian Aboriginal groups, but provides no source for the information. We lack sufficient data to discuss this area in further detail.

6. Most of these are primary sources (dictionaries, grammars, and word lists; see Appendix and References). Our information for several languages comes from Chan (1998–2011; used with permission); we gratefully acknowledge this useful source of comparative numeral data.

our sample having numeral terms documented as both exact and approximate, we included these as “true” numerals for the purposes of this study.

Vague or ambiguous uses of numeral terms appear to be particularly common in Australia, where they are documented for 24 % (29 languages) of the languages sampled. Several examples also appear in South America (10 of the 190 total languages sampled);⁷ however, only five of these (Pirahã and the four members of the Yanomami family) are classified here as hunter-gatherer focused, while the rest are relatively agricultural. No vague/ambiguous numeral uses were identified in the North American, African,⁸ or Asian languages surveyed. Vagueness or ambiguity of numeral terms does not appear to be closely associated with hunter-gatherer subsistence, since this property is neither typical of nor unique to hunter-gatherer languages. Vagueness/ambiguity does appear to be associated with restricted numeral systems (see also Hammarström 2010: 17) – most of the languages in our sample having vague/ambiguous terms are limited to five or fewer numeral terms – but it is not a general property of such systems, which in most cases do not appear to allow vague interpretations of numeral terms (see Bowern & Zentz 2011 for additional discussion concerning Australian systems).

3.2. *Limits of systems*

A clear measure of numeral complexity is the upper limit of the system. We define the upper limit according to the highest attested native (i.e., non-loan) numeral term in a sequence.⁹ This definition excludes higher terms in systems that do not end discretely; for example, some Australian systems have additional terms for certain higher numerals out of sequence (usually reserved for particular entities, such as playing cards), and in some South American systems, such as Hup (Nadahup), terms for 11 to 14 may also be used for 16 to 19 and are thus understood as tally terms rather than true numerals (i.e., they mark elements in a sequence, but do not refer to a precise quantity; see Section 2 above). In most languages where loan numerals exist, these pick up where the

7. These are Tenharim (Tupí-Guaraní), Hixkaryana (Carib), Kulina (Arawá), Kwaza (isolate), Esse Ejja (Tacanan), and the four members of the Yanomami family. We also include Pirahã (Mura) here, in keeping with our criteria above, although we recognize that D. Everett (2005 *inter alia*) and Frank et al. (2008) provide cogent arguments to show that the Pirahã quantifying terms are not true numerals.

8. With the exception of the Kxoe term *x/óa*, which functions both as a verb ‘to be little, few, some’ and as an alternative way (among other terms) of expressing the quantity ‘three’.

9. That is, our working definition of limits excludes material that is obviously not native to the language in question. For example, several Pano languages (South America) have borrowed Quechuan numeral terms for values above 5 (apparently reflecting elaboration of the native system via language contact); in such cases, the numeral limit is here assessed as 5. Borrowing of numeral terms within the sample is addressed in Section 4.3.

native terms leave off, and are therefore excluded; however, in the few cases where there are loans that intervene in a sequence of native terms, the upper limit is taken to be the highest native term in a sequence with no more than two intervening non-native numerals.¹⁰ This definition of numeral limits includes conventionalized terms that are internally analyzable (i.e., have transparent etymological sources); the limits of opaque lexical “atoms” are considered below.

Detailed information on numeral limits is frequently unavailable. For many languages – primarily for systems going above 10 – information on ACTUAL limits was not accessible, so the highest ATTESTED numeral term was taken instead to represent an upper value in the system. Because of the imprecise nature of these data, our discussion of the limits of systems prioritizes three broad categories: 5 or under; between 6 and 19; and 20 or over (note that documentation of numerals above 20 is particularly patchy). A further advantage of these categories is that they are likely to correspond roughly to the incremental steps a developing system will take (i.e., languages tend to develop bases that generate sets of higher numerals, as opposed to simply adding numerals to a sequence one at a time). Those languages where reliable data were unavailable even for values under 20 were excluded from the sample.

We also focus on documented limits to systems, as opposed to reconstructed changes to numeral systems over time. There is evidence in some cases that native systems originally did attain higher limits, but have been replaced by borrowed numerals from European or other languages. For example, the Aslian languages Jahai (Burenhult 2005) and Semelai (Kruspe 2004), of Southeast Asia, have borrowed almost all of their numerals from Malay, and have lost most of the earlier Mon-Khmer numeral forms that are still attested in related languages. Conversely, it is well known that languages may augment their limits through borrowing and/or innovation, as has been argued for Hup and Yuhup (Nadahup, South America; see Epps 2006). It is often difficult to distinguish between elaboration and replacement via borrowing.

Examples of languages with relatively low upper limits include Bardi (2), which has basic numeral terms for 1 to 3, with 4 a reduplication of 2 (Bowern forthcoming). Some speakers give *ni-marla* ‘hand’ as a way to refer to 5, but not all speakers accept this.¹¹ Another example of a language with a small

10. There are no attested cases of a sequence of more than two loan numerals followed by an extended sequence of native terms.

11. Speaker variation is sometimes documented in the Australian numeral systems, but not systematically so. For Bardi, speakers differ greatly in the extent to which they accept numerals beyond those given in (2). Materials from the 1920s include forms such as *gooyarra agal gooyarra agal gooyarra agal gooyarra* ‘two and two and two and two’ (for 8), but current speakers uniformly described such phrases as ad hoc enumerations which sounded contrived and ungrammatical. However, the presence of such formations in earlier materials – which date from a time when Bardi was still used in daily conversation – may suggest that the system has contracted as speakers’ knowledge of English has increased.

system is Dâw (3), which has basic numeral terms for 1 to 3 only; above this (up to 10) generic terms indicating ‘even’ or ‘odd’ may be used, typically together with finger gestures (Martins 2004: 391).

- (2) Bardi (Nyulnyulan, Australia)
<i>arinyji</i>	‘1’
<i>gooyarra</i>	‘2’
<i>irrjar</i>	‘3’
<i>gooyarra-gooyarra</i>	‘4’
- (3) Dâw (Nadahup, South America)
<i>m’ε?</i>	‘1’
<i>tí:bm</i>	‘2’
<i>mutuwap</i>	‘3’
- (‘4’ to ‘10’ indicated by fingers + ‘one brother exists/does not exist’)

We find striking variation in numeral limits among the hunter-gatherer languages sampled, most notably across the case study areas (see Figure 1).

The Australian languages surveyed tend generally toward low limits. None of these languages have numeral terms above 20; accordingly, they may all be classified as “restricted” (Comrie 2011; see Zentz & Bower 2011). Most of the languages (80 %, $n = 97$) have an upper limit of 3 or 4, but several languages have contiguous systems that extend up to 2 (4 %, $n = 5$), 5 (8 %, $n = 10$), 6 (4 %, $n = 5$), or 10 (3 %, $n = 4$); one language, viz. Gamilaraay (Pama-Nyungan), goes to 20.

Conversely, languages in the California/Great Basin region tend toward relatively high limits. All of the hunter-gatherer languages sampled (for which adequate data are attested) have upper limits of over 10 ($n = 32$).¹² Most (88 %, $n = 28$) have attested terms up to 30 or above, while the remaining 12 % ($n = 4$) have attested limits of between 12 and 25. About half (47 %, $n = 15$) have documented terms for 100 or above and 12 % ($n = 4$) have attested native terms for 1000 or above.

Numeral limits for South American hunter-gatherers are generally low. Of the languages for which reasonably reliable data on limits are available ($n = 18$), 61 % ($n = 11$) have an upper limit of 5 or below (of these, the four Yanomami languages are limited to 2, three other languages have limits of 3, one goes up to 4, and two to 5). Six languages (33 %) have limits of 10, and only one (the isolate Huaorani; 6 % of total) is documented as having numerals beyond 20.

12. The alternative counting system in Seri (not included in these figures; see Section 2 above) is lower, with an upper limit of 10; the more complex system has numerals attested up to 1000.

Limits in the African hunter-gatherer languages are more variable, but also tend to be relatively low. 41 % ($n = 7$) have an upper limit of 5 or below (these include some Bantu and Cushitic varieties), 24 % ($n = 4$) languages have attested limits of 10, and 35 % ($n = 6$, all Bantu or Cushitic) have attested limits between 100 and 1000. We note that Bantu and Cushitic varieties – which presumably represent cases of past language shift – are represented in all of these categories; on the other hand, the southern African hunter-gatherer languages (Khoekhoe, Tuu, and Kx'a families) have uniformly low upper limits of 10 or below.

In Asia, the high numeral systems of the northeastern hunter-gatherer languages all appear to be of native origin, and exhibit attested values well beyond 100. The Aslian and Agta languages of Southeast Asia use numeral systems that derive from non-hunter-gatherer languages (Agta through language shift and Aslian primarily through borrowing); they appear to have maintained the complexity of these systems since adopting them.

A comparison of these results with the patterns exhibited by non-hunter-gatherer languages reveals that the clearest numeral trends in the regions investigated are areal, rather than directly subsistence-related (compare Comrie 2011, who shows restricted systems to be clustered predominantly in Australia and South America). Australia is characterized by both low numeral limits and hunting-gathering subsistence, but because agriculture is entirely absent it is impossible to distinguish between areal and subsistence-related patterns. The California/Great Basin sample reveals little difference between the hunter-gatherers and the more agriculturally focused groups; of the latter, close to two-thirds of the twenty languages included in our survey have attested limits of 100 or above, several go above 1000, and only one is below 20. These results are consistent with those of Hanke (2005) and Comrie (2011) for North American languages more generally. The Asian hunter-gatherer languages examined also conform to broader areal trends (Comrie 2011, Hammarström 2008).

There are some indications that subsistence pattern may be relevant to numeral limits within certain regions. In South America, as shown in Figure 2, the hunter-gatherer systems surveyed are twice as likely as the agriculturalist and mixed-subsistence systems to be limited to 5 or below, whereas the more agriculturally oriented languages are far more likely to extend beyond 20 (of these, at least 8 % go to 100 or above,¹³ and a few languages – primarily Quechuan – have documented terms into the thousands). In general, then, it appears that systems of very low limits are widely attested across subsistence foci in South America, but only agriculturally oriented peoples (with the exception of the Huaorani) have elaborated their systems beyond 20. However, the fact that many agriculturalist groups have not done so suggests that

13. As noted above, more languages may in fact go higher than 100, but lack documentation.

Figure 1. *Distribution of highest attested numerals across hunter-gatherer languages (SAM = South America, NAM = North America, AUS = Australia, AFR = Africa)*

subsistence-related practices are not themselves a sufficient requirement for elaboration.

Similarly, while a high proportion of the African hunter-gatherer languages have low limits (10 or below), all of the fifteen agricultural/pastoral/mixed-

Figure 2. *Numeral system limits and subsistence patterns in South America and Africa (the uppermost point on the y-axis represents values of 200 or beyond; AG = agriculturalist, HG = hunter-gatherer, MX = mixed subsistence)*

subsistence groups surveyed have quite high limits, ranging from 99 or 100 to far into the thousands or even beyond (Figure 2). The differences between the distributions across the two regions are also interesting; in South America, it is the relatively agricultural groups that exhibit a range of numeral system limits, while the hunter-gatherers are more uniform; in Africa, we see the reverse.

For the South American and African languages, we note that although many of the languages within our sample are not independent due to genetic relationship, membership in the same family is not in itself a predictor of limit type, especially for the larger and older families. In South America, a hunting-gathering subsistence focus is largely consistent within families (notably Yanomami, Nadahup, Kakua-Nukak, and Guahiban); these languages all tend to low limits. Among more agriculturally oriented language families, an association between numeral limits and language family is significant in some cases (particularly in relatively shallow families such as Tukanoan, favoring limits between 10 and 20, and Quechuan, with limits mostly well over 20) but not for others (such as Arawak, Carib, Pano), in which attested numeral limits vary more widely across member languages. In Africa, many of the language families are distributed between hunter-gatherers and agriculturalists/pastoralists (particularly Khoe, Ubangian, and Bantu within our sample), but numeral limits vary widely within these families.

As a final note, we observe that patchiness of data is unlikely to give rise to systematic biases corresponding to non-numeral factors. For the most part, there is no apparent reason to suppose that the individuals who documented these languages were more or less likely to record higher numerals, if they existed at the time, depending on geographical region, subsistence pattern, etc. – although there is the possible caveat that some researchers may have associated low numeral systems with stereotypical views about “primitive” languages and did not fully explore system limits. There is also no evidence to suggest that regional or subsistence factors contributed to the replacement of native terms with European numerals (resulting in the truncation of native systems) in the main case-study regions considered here.¹⁴ In South America, for example, we would actually predict that agriculturalists’ languages would be more prone to European influence, because agriculturalists’ relatively sedentary, river-based existence has been more conducive to interaction, but in fact we find that the higher-limit systems are predominant in these languages and not in those of the hunter-gatherers.

3.3. *Extent of atomic native numeral terms*

We consider the upper limit of “atomic” native lexical items in a numeral system as a factor associated with numeral complexity, particularly regarding its change over time. Lexical items of this kind are defined as monomorphemic roots that are NOT transparently derived (either historically or synchronically) from a word that means something other than this precise quantity (i.e., a non-numeral term or a distinct numeral base), and are not loans from another language.¹⁵ The limit of such terms is defined as the end of a sequence, with no gaps consisting of more than one intervening term that is not itself an “atom”. For example, in some East Tukanoan languages in the Amazon, 1 to 3 are unanalyzable atoms (with no obvious etymological source), whereas 4 means literally ‘have companion’, 5 is literally ‘one hand’, and 6+ are complex terms involving added fingers/toes; thus the limit of atomic numeral terms in these languages is 3, although their overall numeral limit is higher (see Ramirez 1997, Aikhenvald 2002: 108). A relatively high limit to these underived lexical atoms is likely to reflect a more established, older degree of numeral complexity in a given language, because etymological transparency tends to be obscured over

14. In southeast Asia, on the other hand, the replacement of numerals by borrowing from other regional languages may indeed be an areal trend.

15. Some terms for 1 in our sample (particularly in Australia and Amazonia) have alternative meanings such as ‘alone’, ‘together’, ‘other’, but since it is not known whether the numeral or alternate meaning is primary these are not counted as historically derived. In most other cases, etymological transparency is taken as evidence that the numeral meaning has emerged from a distinct source.

time and/or through frequent use via the processes of lexicalization that affect linguistic expressions in general (as in *God be with you* > *goodbye*; see, e.g., Crowley & Bower 2010).

Interestingly, the hunter-gatherer languages in all four case study regions tend to relatively low upper limits of underived native lexical items, as Figure 3 illustrates; nevertheless, some variation across regions exists. In Australia, all numeral terms in the system are lexical atoms in 32 % ($n = 39$) of the languages surveyed; that is, these systems do not undergo a transition from a series of atoms to one of derived/loaned forms.¹⁶ Within the full sample, the limit of atomic terms is in most cases either 2 or 3. Other upper limits to underived terms are 1 ($n = 6$), 4 ($n = 7$), 5 (the Pama-Nyungan language Wirangu), and 8 (the Pama-Nyungan language Kaurua).

In the California/Great Basin region, in contrast to the higher overall limits attested in the majority of numeral systems, the upper limits of numeral atoms in hunter-gatherer languages cluster at 2 (28 %, $n = 10$) and 4 (42 %, $n = 15$). Other upper limits to numeral atoms are 1 (the isolate Esselen), 3 ($n = 4$), 5 ($n = 4$), and 6 (the isolate Washo).¹⁷

In South America, numeral atoms in the majority of the hunter-gatherer languages for which reliable data exist have an upper limit of 2 (62 %, $n = 8$). Others have 1 (2 languages of the Nadahup family), 3 (the isolate Yámana), and 4 (the Arawak language Iñapari).

Among the African hunter-gatherer languages, all numeral terms in the system are atoms for about half ($n = 8$) of the sample. The range of atomic limits tends on the whole to be somewhat higher than that found in the three other regions, but is variable, from 2 (12 % of the hunter-gatherer languages, $n = 2$), 3 (29 %, $n = 5$), 5 (35 %, $n = 6$), and 10 (24 %, $n = 4$).

In comparison, the native systems found in the small set of Northeast Asian languages investigated are variable but tend to be relatively high, with atomic numeral limits of 4 (Ainu), 7 (Ket and Yukaghir), and 10 (Nivkh).¹⁸

On the whole, the limits of numeral atoms for hunter-gatherer languages vary less across the four focal regions than do the limits of numeral systems more

16. Note that we do not include more recent augmentations/substitutions of systems using European numerals, as discussed in Section 4.3 below.

17. Interestingly, the simpler Seri system has an upper “atomic” limit of 9, despite its lower overall limit (10), whereas numeral “atoms” in the more complex system are limited to 5. This may be a further indication that the simpler system is the older one. It also raises the question of whether the elaboration of productivity via the adoption of bases may in certain cases supplant earlier atoms, such that an increase of complexity along one parameter leads to a decrease along another (we thank Victor Golla for bringing up this point; personal communication to Jane J. Hill).

18. The Aslian languages to the south have preserved earlier Mon-Khmer “atoms” for 1 (Jahai) and 1, 3, 5 (Semelai), while the rest of their numerals are Austronesian loans.

Figure 3. *Highest atomic native numeral in hunter-gatherer languages*

generally. The same is largely true within these regions: hunter-gatherers do not deviate dramatically from the wider areal patterns, although they do tend to somewhat lower limits. In California and the Great Basin, the limit of atoms in the twenty-one additional languages surveyed from agriculturalist/mixed subsistence groups clusters around 2 and 4 – as is also true for the hunter-gatherers – although an additional eight languages also exhibit limits between 6 and 10 (and one, the Uto-Aztecan language Hopi, appears to have a limit of 20, though several of the intervening forms are etymologically transparent).¹⁹ In South America, limits for numeral atoms cluster around 2 and 3 for agriculturalist and mixed-subsistence groups, with several more at 4 (while hunter-gatherers are predominantly at 2); again, it is noteworthy that the Quechuan languages

19. For 11 to 19, Hopi also employs a different set of numeral terms for modification that are base-10; the atomic variants are used primarily in counting.

– the primary representatives of a strongly stratified, state society – tend to be quite distinct, with limits of 10. In Africa, the non-hunter-gatherer languages all exhibit atomic limits of 5 or above, as do 59 % of the hunter-gatherers. Those African languages attaining an atomic limit of 10 (although in a few cases the sequence is interrupted by a non-atomic word for 9) comprise 60 % of the non-hunter-gatherers and 24 % of the hunter-gatherers.

A high limit to numeral atoms is obviously restricted by the overall limit of a numeral system (in other words, if there are no numerals over 3, then there will be no numeral atoms above 3). However, high system limits are not strongly associated with high limits of lexical atoms across much of our sample, particularly in the Americas.²⁰ This lack of a clear correlation is most striking for the languages of the North American sample, which tend to have relatively high upper system limits but low limits to lexical atoms. These facts suggest that the elaboration of complexity in many of the North American numeral systems was a relatively recent event.

A lack of a strong correlation between system limits and atomic limits is also true of the South American sample, in which roughly half of the languages having the relatively high limits (compared to other languages in the region) of 3 or 4 to their numeral atoms are found in languages with overall numeral limits of 5 or below. There are nevertheless a few exceptions to these trends in the Americas, particularly the Quechuan languages in South America and the agriculturalist Kiowa-Tanoan languages in North America, which display both high system limits and high atomic limits.

Although our sample for Africa is more limited, it shows a somewhat distinct pattern from that seen in the Americas. All of the languages surveyed in this region that have high system limits (of 99 or 100 and higher) also have high atomic limits (5 or above, with over half having an atomic limit of 10). The same trends appear to hold among the Asian languages surveyed as well (with the marginal exception of Ainu, which has an atomic limit of 4).

3.4. *Variability of bases*

The variability of bases used in numeral systems is a further factor associated with numeral complexity. Following Comrie (2011) we define “base” here as “the value n such that numeral expressions are constructed according to the pattern $xn + y$, i.e., some numeral x multiplied by the base plus some other numeral y ” (or of the more simplified form xn or $n + y$).²¹ In keeping with this

20. The issue is not relevant for Australia, where system limits are uniformly low.

21. This definition is better suited to languages with low numeral limits than is the definition given in Hammarström (2010: 15), which makes reference to a higher base than the one being defined.

definition, a given language may employ multiple bases; typically, the highest base used is the most productive (i.e., is used to form the largest number of other numeral terms), whereas an “alternative base is used only in the construction of a small proportion of relevant numerals” (Comrie 2011). Clearly, higher bases (10 or 20) are likely to occur in relatively more complex systems having more productive power, whereas lower maximum bases (such as 2 or 3) are more common in lower-limit systems.²²

An example of a system with a maximum base of 2 is Garrwa (Furby & Furby 1977) and an example for a maximum base of 5 is Tukano (Ramirez 1997: 332); see (4) and (5), respectively.

- (4) Garrwa (Garrwan, Australia)
<i>kujarra</i>	‘2’
<i>kujarra-yalkunyi</i>	‘3’ (‘2 + 1’)
<i>kujarra-kujarra</i>	‘4’ (‘2 + 2’)
<i>kujarra baki kujarra yiŋamali</i>	‘5’ (‘2 and 2 + 1’)
<i>kujarra baki kujarra baki kujarra</i>	‘6’ (‘2 and 2 and 2’)
- (5) Tukano (East Tukanoan, South America)
<i>ni’kâmukã-</i>	‘5’ (‘one hand’)
	‘6’ to ‘9’ = ‘one hand + 1–4 fingers’
<i>piâmukã-</i>	‘10’ (‘two hands’)

A language that employs more than one base is Wintu (Pitkin 1985), which uses bases 3, 4, 10, and 20; see (6). Lower-level bases may appear in as few as one or two other numeral terms (as in Wintu); in other words, according to our definition of base, these need not be productive within a given numeral system (although they may have been more productive in the past before a system was elaborated).

22. We do not include high-level terms for 100, 1000, etc., which frequently form a kind of base for still higher numeral terms, where these exist (e.g., English *one hundred twenty*). This decision is in keeping with convention, and also facilitates comparability within our sample, especially given the patchy availability of detailed information about such high-level numeral terms. We also do not consider the ordering of components within numeral terms (e.g., German *hundertundeinundzwanzig* [100 + (1 + 20)] vs. English *a hundred twenty-one* [100 + (20 + 1)]) – although, as a reviewer points out, the inconsistent ordering of larger and smaller elements within the German expression involves more complexity than the consistent ordering in the English term.

(6)	Wintu ("Penutian", California)	
	<i>panuλ</i>	'3'
		'6' = 'twice 3'
	<i>λ'aw</i>	'4'
		'8' = 'twice 4'
	<i>tigeles</i>	'10'
		'5' = 'half, one side'
		'9' = 'minus one'
		'11'–'19' = '10 + 1–9'
		'50' = 'half × 10'
	<i>k'ete wint^hun</i>	'20' (lit. 'one person')
		'30' = '20 + 10' (alternatively, '3 × 10')
		'40' = '2 × person' (or '4 × 10')
		'60' = '3 × person'
		'70' = '3 × person + 10'
		'80' = '4 × person'
		'90' = '4 × person + 10'

The presence of multiple bases may be a clue to elaboration in the history of a numeral system; i.e., a layering of a higher-base strategy with higher productive potential (e.g., base 5 or 10), onto an earlier strategy with lower potential (e.g., base 2); see Swadesh (1971: 188), Hurford (1987: 274), and also Epps (2006, for discussion of this process in the Nadahup languages of Amazonia). This layering process has undoubtedly occurred in some of the North American languages sampled; in at least some cases, there is evidence that restructuring was motivated by European contact during the period of missionization in the late eighteenth to early nineteenth centuries (e.g., in Chumash, see Beeler 1986). Some languages have as many as three or four identifiable (largely non-productive) bases, as does Wintu. It is likely that the actual number of bases in use may be slightly higher than the figures below convey, due to limited documentation.

We turn first to the upper values of bases attested in the numeral systems under investigation. These values vary considerably both within and across the focal regions (see Table 1). In Australia, a high proportion of the languages surveyed do not use any base at all (39 %, $n = 47$). A large number of others use base 2 to construct at least one additional numeral term (57 %, $n = 70$). In addition, there are a few languages that use an uppermost base of 3 (the Pama-Nyungan language Adnyamathanha), 4 (the Pama-Nyungan language Kaurna), and 5 ($n = 2$, the Pama-Nyungan languages Muruwari and Gamilaraay).

In the California/Great Basin region, most of the hunter-gatherer languages surveyed have a highest attested base of 10 (63 %, $n = 20$). Several (16 %, $n = 5$) employ a highest base of 20 (Yok-Utian, Uto-Aztecan, others; see Farris

Table 1. *Highest base attested in hunter-gatherer languages*

Highest Base	Australia	North America	South America	Africa
0	47		12	9
2	70			2
3	1			
4	1	3		
5	2	1	7	1
10		20		6
16		1		
20		5		
25		1		

1990). Of the remaining languages, others employ a highest base of 4 (three Chumashan languages), 5 (the Uto-Aztecan language Gabrielino/Tongva), 16 (the Yukian language Yuki), or 25 (the Uto-Aztecan language Luiseño).²³

Of the other regions sampled, some two-thirds of the nineteen South American hunter-gatherer languages use no base at all ($n = 12$), while the rest ($n = 7$) use base 5. Just over half ($n = 9$) of the African hunter-gatherer languages likewise have no base; of the rest, one uses a highest base of 2, one of 5, and the remaining six languages have a highest base of 10. In Asia, the borrowed Austronesian systems are base 10; in the northeastern languages, we find uppermost bases of 10 (Nivkh and Yukaghir) and 20 (Ket and Ainu).

In general, higher uppermost bases correspond to higher upper limits to numeral systems – as expected, given that higher bases impart more productive power to a system. Thus the variation in uppermost bases across the four focal regions corresponds closely to the variation seen in upper system limits. Within regions, variation relating to subsistence pattern is consistent with the generalizations made above for overall system limits. In California and the Great Basin, agriculturalist languages (like those of hunter-gatherers) favor base 10, with a few attestations of bases 5 and 20; this preference for decimal systems is reflected for North America generally, see Comrie 2011). Uppermost bases among South American mixed subsistence and agriculturalist languages cluster at 0 and 5, as do those of the hunter-gatherers, although proportionally a few more non-hunter-gatherer languages favor 5 (42 % vs. 32 %). Uppermost bases of 2, 3, 4, 10 (including most Quechuan languages), and 20 are also attested. The African sample shows a more pronounced difference relating to

23. The simpler Seri system has no attested base at all, uniquely among the North American languages considered here (including the more complex Seri system, which has a highest base of 10 and additional unproductive bases of 5 and 2).

subsistence, but corresponding closely to system upper limits; all of the non-hunter-gatherer languages have a highest base of 10 (and high upper system limits); the same is true for only 35 % of the hunter-gatherers, whereas the majority of these languages have no base at all (and low system limits of 5 or below).

We turn next to the existence of multiple bases (of which only the uppermost is typically productive), as illustrated in Figure 4. Multiple bases are very limited in Australia; only two languages in the sample have more than one attested base: Gamilaraay and Muruwari (Pama-Nyungan, Macro-Central New South Wales) each have three bases, with lowest 2, intermediate 3 or 4, highest 5, and with an upper system limit of 20 or 10, respectively.²⁴

In the California/Great Basin region, in contrast, of the hunter-gatherer languages for which adequate data are attested ($n = 30$), a high proportion (73 %, $n = 22$) have more than one base.²⁵ Many ($n = 10$) have three bases, and a few languages have four (the “Penutian” language Wintu, see (6) above, and the Uto-Aztecan language Tübatulabal) or even five (the Uto-Aztecan language Serrano). About half of the languages with multiple bases ($n = 16$) have a lowest base of 2, 3, or 4, and many use intermediate bases as well; their highest base is in most cases 10. The rest have a lowest base of 5 (with highest base of 10, 20, or 25), and one language has a lowest base of 6. A few further traces of a non-productive base 6 were detected in this region – noteworthy given the crosslinguistic rarity of senary systems (see Beeler 1961, Plank 2009, Hammarström 2010).

Elsewhere in the world, we find that only one of the nineteen South American hunter-gatherer languages sampled has more than one base (2 and 5) – Huaorani, which also is the only hunter-gatherer language with an overall limit above 10. Multiple bases are likewise rare among the African hunter-gatherer languages, of which only two of those sampled ($n = 17$), Sandawe (isolate) and Bayanga Aka (Bantu C10), have more than one base (5 and 10). The Asian languages investigated tend to have one base (and favor a decimal system), but Ket and Ainu use base 10 up to 20, then base 20.

In comparison with broader regional trends, we again find little difference between hunter-gatherers and others in the California/Great Basin region, where most languages have between one and three bases regardless of subsistence pattern. In South America, 20 % ($n = 30$) of mixed subsistence and agriculturalist groups have more than one base (most of these have two bases, but three languages have three, viz. the Arawak language Palikur, the

24. A few others have an additional term for 10 (based on 5) but apparently lack the intervening sequence 6 to 9. Data are uncertain on this point.

25. However, a number of these are etymologically semi-opaque, and are not necessarily obvious to speakers.

Figure 4. Existence of multiple bases in hunter-gatherer languages

isolate/unclassified language Puinave, and the isolate Andoke), as opposed to only one hunter-gatherer language (Huaorani); this is clearly dependent on the tendency for low overall system limits among the hunter-gatherers. In Africa, six (40 %, and marginally a seventh) of the non-hunter-gatherer languages have two bases, as do two (12 %) of the hunter-gatherer languages, also in keeping with higher upper system limits.

To summarize these results, the patterning of bases tends to correspond roughly to that observed for the limits of systems, with some regional variation. Australian languages (with their overall low limits) are particularly likely to have no or only one base (usually base 2), whereas two-thirds of California/Great Basin languages (which tend to much higher limits) have multiple bases (of which the highest and most productive is predominantly base 10). South America is more variable, with over a third of the total languages sampled having no attested base (predominantly those with low limits), about a

fifth having two (or in a few cases three) bases, and base 5 typically the highest used; however, hunter-gatherer languages in this region have predominantly zero to one base only. In the African sample, most low-limit systems (of which all occur among hunter-gatherers) use no base, whereas higher-limit systems have predominantly one to two bases (of which the highest is base 10). As noted above, the exuberant layering of bases seen in the North American sample (and to a lesser degree in the South American one; see Epps 2006) may indicate a relatively recent elaboration of some systems.

3.5. *Numerals and sociocultural parameters*

As we have seen here, and as evidenced in other typological surveys of numeral systems (such as Comrie 2011 and Hammarström 2010), numeral complexity has a strong areal component. Thus, while we may observe that restricted systems tend to cluster in regions in which hunting and gathering are focal subsistence practices (Australia, South America, southern Africa), it is difficult to tease out the relevance of subsistence, as opposed to other regional trends, to numerosity. Moreover, the fact that relatively complex numeral systems exist widely among hunter-gatherers in North America, Siberia, and other parts of the world indicates that agriculturally oriented subsistence is not required for the development of numeral complexity. However, a comparison of numeral variation *WITHIN* regions where subsistence focus varies and restricted systems are widely attested – i.e., South America and Africa, but not Australia and North America – suggests that a meaningful correlation between numeral complexity and subsistence may in fact exist. In these regions, as discussed above, numeral complexity (as measured by the parameters considered here) is predominantly lacking in hunting-gathering groups, whereas more agriculturally oriented groups range from more to less restricted in South America, and tend to high upper limits in Africa. Nevertheless, as our results also show, even relatively simple numeral systems may exhibit a wide range of variation.

Our findings suggest that, while the presence of agriculture itself does not directly drive the development of numeral complexity, it may well be associated with other aspects of social organization that, at least in some cases, foster numeral elaboration. Exactly what these may be is not yet clear, however. Among the variables associated with subsistence pattern is relative mobility (nomadic, semi-nomadic/seasonal, sedentary); in the languages surveyed, this was found to correlate closely with subsistence pattern, although there are various exceptional cases of settled foragers, such as the Seri of Mexico, who depend heavily on sea life. Relatively small population size and density are other potentially relevant factors; however, population estimates are unfortunately available only for contemporary populations in much of our sample (particularly in South

America), and are almost certainly very different from figures predating European contact.

A likely variable associated with numerosity is exchange. Hunter-gatherers around the world are widely involved in trade, but there may be significant differences in the scale, scope, and delayed vs. immediate nature of exchange, themselves relating to social network structure, division of labor, food storage practices, etc. Trade-focused interaction of hunter-gatherer groups with agriculturalists has been shown to correspond to the elaboration of numeral systems in at least one case (the Nadahup languages of Amazonia, see Epps 2006); compare also the borrowing of non-hunter-gatherer numerals among the Aslian groups in Asia and among various South American languages in contact with Quechua. However, the sample size relating to documented cases of high interaction between hunter-gatherers and other groups is small in our survey, so we must leave this question for future research.

It is similarly important to ask why hunter-gatherers in other parts of the world, such as North America and Siberia, have developed complex numeral systems – clearly, agriculture is neither a necessary nor a sufficient condition for numeral elaboration. Complex exchange practices may develop among hunter-gatherers as well as agriculturalists, as evidenced by California/Great Basin peoples' use of shell money (Loeb 1926). Other localized practices may also contribute to a need for numerals, such as astronomical observation, reindeer herding, and perhaps even highly detailed basketry such as that found among the California/Great Basin peoples. A more nuanced understanding of the dynamics of numeral elaboration will be best informed by a fine-grained level of ethnographic study.

4. Historical development of numeral systems

4.1. *Traces of change*

The numeral systems examined here – largely understudied and exhibiting a wide range of complexity – are a rich source of insights into the dynamics of numeral elaboration over time. In particular, etymological transparency offers important clues into these processes. As noted above, such transparency tends to be obscured over time by the processes of lexicalization and phonological reduction that are general in language; thus the origins of low-level terms in particular are often opaque in older, more established numeral systems. Systems that have experienced relatively recent elaboration or renovation are more likely to reveal traces of these processes.²⁶ As discussed above, a detectable

26. The tendency for processes of language change to become obscured over time is a generalization that guides historical methodology (see, e.g., Crowley & Bowerman 2010); however, we recognize that relative transparency cannot be taken as definitive proof of recent change, because rates of change are not constant across languages or linguistic elements.

layering of bases can reflect stages by which a numeral system has built up its productive power; such layering is most apparent in the North American case study region, where restructuring occurred in at least some languages due to European influence, and in others may well have preceded this contact. Similarly, low upper limits of “atomic” or opaque native numeral lexical items may also suggest a relatively recent elaboration.

In the following discussion, we focus on the historical sources of numerals in the lower ranges of systems. In the upper ranges (typically above 5, 10, or 20), numerals tend to owe their forms to the productive use of bases; in the lower ranges, however, terms are more likely to derive from other processes of lexical innovation or borrowing, and thus are less predictable. Traces of these processes provide insights into how numeral systems develop in languages generally, and inform our understanding of the numeral histories of particular languages.

4.2. *Etymological sources of numeral terms*

The sources of low-level numeral terms are obscure in many of the world’s better-studied languages, which tend to have opaque terms below 5 or 10. Yet in some of the numeral systems surveyed here, etymological sources of these low-level terms are still easily detected, often innovated from non-numeral sources.²⁷ As with the parameters examined above, however, we see considerable variation across case study regions, with numeral etymologies particularly visible in South America.

The Australian systems are broadly consistent in revealing few non-numeral etymological sources (see Bower & Zentz 2011). Terms for 1 are often related to other words meaning ‘together’ or ‘alone’, but (as noted in Section 3.1 above) it is not clear whether the numeral is derived from the other meaning, or vice versa. Words for 2 in our sample are all opaque (although a number are loans, see below), except in a few cases where they are associated with terms meaning ‘pair’ or a dual marker – but again, the direction of derivation in such cases is not clear, and both terms are quantitative. Terms for 3 to 4 and above are frequently derived from 2; non-numeral sources are limited to the term for 3, **kulparri*, in the Karnic subgroup of Pama-Nyungan, which has been reconstructed to ‘emu’, undoubtedly motivated by the bird’s three large, splayed

27. Numeral sources (e.g., ‘2 and 2’ for ‘4’) are also addressed above (Section 3.4).

toes (Luise Hercus, personal communication to Bower).²⁸ Where terms for 5 to 10 exist, these are usually based on ‘hand’, and terms for 10 to 20 on ‘foot’; crosslinguistically, these are typical sources for these values.

The languages of California and the Great Basin also reveal few non-numeral etymological sources. Terms for 1 to 3 are opaque in all languages of the sample, except for a doubtful link between 3 and ‘big’ in some members of the Uto-Aztecan family. Terms for 4 are derived from 2 in a number of languages in the sample, and Comanche 4 may derive from ‘last-exact’. A common source for terms for 5 is ‘hand’ (attested in over half the languages sampled, of both hunter-gatherers and agriculturalists), and complex terms for 6 to 9 typically involve other numerals (as bases) and/or reduplicated forms, with the (partial) exception of Seri 6 ‘chest/breast + 1’; terms for 10 typically derive from other numerals or ‘hand’.

Similarly, few non-numeral etymological sources for low-level numerals were encountered in the African and Asian languages surveyed. In Africa, numeral terms above 5 in several Bantu languages relate to fingers (see also Schmidl 1915, Zaslavsky 1973, Zerbán & Krifka 2008), as do most terms above 3 in Khoe languages. The term for 3 in Ju|’hoan (Kx’a) may be related to the word for ‘clay pot’, and 2 in Baka (Ubangian) may derive from ‘friend, brother’. Among the Asian languages considered, Ket, Ainu, and Yukaghir use additive or subtractive strategies for some or all terms between 6 and 9; in Ainu 5 is derived from ‘hand’ and 10 from ‘two sides’.

The South American languages are the most intriguing from the perspective of numeral etymologies (see Epps & Hansen 2011 for detailed discussion). In addition to terms derived from other numerals, as seen in the other case study regions, we find a range of distinct etymological sources for low-level numeral terms. These tend to derive from features of the natural or cultural world that have a particular number of salient components, although their motivation is not always obvious. As in Australia, terms for 1 are frequently related to ‘alone’ or to demonstratives, but the direction of derivation is unclear. Sources for 2 include ‘eye’ in Hup (Nadahup) and Gavião (Tupí), ‘deer footprint’ in Xerénte (Je), ‘help’ in Urarina (isolate), and ‘proliferate’ in Matsigenka (Pano). Among terms for 3, we find ‘rubber-tree-seed’ in Nadahup languages, ‘rhea bird footprint’ in Xerénte (Je; the rhea bird has three distinctive toes), ‘jar support’ in Yucuna (Arawak; probably a reference to stones or clay pedestals placed in a fire in sets of three), and ‘pronged fishing arrow’ in Hixkaryana (Carib family). More predictably, analyzable terms for 5 and above almost always involve hands, fingers, and feet.

28. Other non-numeral sources may exist, but it is striking thus far that numeral terms in Australia are not only unreconstructable beyond low-level subgroups, but are frequently unetymologizable.

A particularly intriguing feature of the South American numeral etymologies is found in terms for 4, of which a remarkably high proportion in our sample derive from terms involving a social relationship – usually ‘sibling’ or ‘companion’ (7), but in a few cases ‘spouse’ or even ‘enemy’; see Epps & Hansen 2011.²⁹ In several languages, “relational” terms for 3 and/or 5 also exist, possibly formed by analogy with 4.

(7)	a.	Murui (Witoto)	
		<i>naga ama-ga</i>	‘4’ = ‘each brother’
	b.	Hup (Nadahup)	
		<i>bab’-ni</i>	‘4’ = ‘sibling exists/accompanied’
	c.	Suyá (Je)	
		<i>ajmen ndo krám wiri</i>	‘4’ = ‘each with only one companion’

Relational numeral terms were identified in 26 % ($n = 49$) of the total number of South American languages surveyed, including several spoken by hunter-gatherers. These languages are scattered widely throughout the Amazon basin and occur in at least thirteen different families. Because a comparable source for 4 (or other numeral terms) is virtually unattested outside the region, language contact (probably involving calquing) is a likely vehicle of spread (see also Epps 2006). Only a few alternative (non-numeral) sources for 4 are attested in the region, such as ‘shoulder blade’ in Yucuna (Arawak).

We find no evidence here for a correlation between non-numeral etymological sources and subsistence pattern. While it is likely that some association exists between transparent non-numeral sources and simple numeral systems, this is not apparent from our sample. Etymological sources are easily identified only in South America, where the majority of the languages surveyed have limits of 20 or below; in Australia, in contrast, identifiable non-numeral etymological sources are very rare, despite the strong preference for low-limit systems.

4.3. *Borrowing of numeral terms*

Comrie (1999, 2005) notes the particular susceptibility of numeral systems to restructuring through language contact. Contact-induced changes may include restructuring of bases (e.g., Chumash in North America, see Section 3.4), calquing (as in the case of “relational” 4 in South America, see Section 4.2), and lexical borrowing of terms. Borrowing of terms or strategies is a common component of system elaboration, but loaned numerals may also replace native ones. In such cases, clues to the original limits of the native system may be

29. See also the discussion on the *Etnolingüística* forum (<http://lista.etnolinguistica.org/1898>, February 2009; accessed March 2009 and November 2011).

found in the maintenance of doublets (coexistent native and borrowed terms) or in sister languages that have retained inherited forms.

We consider the extent of loan numerals in the languages surveyed, with a focus on terms for 1 to 10 (which are most likely to be attested in the available data). We exclude calques and other forms of contact-induced restructuring, which are nearly impossible to detect consistently in a sample of this size. We also exclude loans from European-derived contact languages (Portuguese, Spanish, English, French, Afrikaans), because these often co-occur with native terms, are often left undocumented in the available sources, and because some contact with European languages is almost universal throughout the case study areas.

Borrowing of low-level numeral terms is attested throughout the sample, though to differing degrees.³⁰ In Australia, terms for 2 and/or 3 show evidence of borrowing in a number of languages (16 % of total languages, $n = 20$); in particular, 2 was borrowed from Pama-Nyungan into Proto-Nyunyulan, Mirndi, and Garrwan, and 3 was also borrowed from Pama-Nyungan into several northern languages (see Bowern & Zentz 2011). In North America, 20 % ($n = 11$) of the total languages sampled have borrowed one to two numeral terms between 1 and 10 from a neighbor; for example, Chumash (Chumashan) appears to have been the source of words for 1 in several languages, and Sierra Miwok (Yok-Utian) has borrowed 5 from Uto-Aztecan. In South America, 6 % ($n = 11$) of the total languages surveyed have borrowed numeral terms from Quechua, typically in series (e.g., 3+, 5+); all of these are spoken in regions bordering on Quechua (e.g., members of the Pano family). No other indigenous donor language was identified in South America. In Africa, 24 % ($n = 4$) of the total sample have borrowed one or more numeral terms between 1 and 10, and of these, Naro (Khoe) has reportedly borrowed a full series (4 to 10) from Khoekhoe (Visser 2001: 232). Among the Asian languages, as mentioned above, the Aslian groups have adopted their numeral systems almost wholesale from Austronesian, as has Agta via the process of language shift; in contrast, the northeastern languages show no evidence of loaned numerals.

It is possible that numeral borrowing is associated with subsistence pattern, but this cannot be ascertained from the existing sample. In South America the borrowed terms are found in relatively agricultural groups, but these peoples have probably been considerably more dependent on hunting and gathering than their Quechua donors. The loans in the North American and African samples are largely limited to hunter-gatherer languages, but more agriculturalist languages would need to be surveyed in order to determine whether this result is significant.

30. In the loan counts discussed here, doubtful cases were treated as 1/2 a loan value.

However, we can observe that the lower rate of borrowing in numeral terms in the South American languages is consistent with the relatively low loan rates in other vocabulary throughout this region, independent of subsistence pattern (see Bowerman et al. 2011). It is also intriguing that the South American numeral terms show more evidence of lexical innovation at the same time as they experience limited borrowing; it is likely that these variations across the case study areas reflect different regional norms regarding the generation of new lexical items.

4.4. *Numeral histories in areal perspective*

The results of this study allow for some tentative generalizations about numeral system histories. Among Australian peoples, there appears to have been little need for talking about precise quantities, as evidenced by the generally low limits to systems and the prevalence of vague or ambiguous terms. Nevertheless, terms for 1 to 3 are widely present across the region and tend to be etymologically opaque, so the existence of a few basic numeral terms may be old (although these terms are not widely reconstructable).

In California and the Great Basin, the presence of at least the low-level numerals (1 to 5) also appears to have considerable time-depth, but it is likely that systems have undergone widespread, relatively recent elaboration, resulting in considerable complexity. Evidence for this scenario includes the low upper limits of underived lexical “atoms”, the layering of multiple bases, and the generally high upper limits of systems. Golla (2011: 219) argues that in California “[t]he regular use of lexified higher numbers almost certainly had to await the development of an intergroup trading economy in which values were set in a standard, countable medium of exchange”, that did not occur before 800–1000 CE. Results from the Comparative Method in Uto-Aztecan also support this proposal; only 1 to 3 reconstruct to Proto-Uto-Aztecan (Stubbs 2011).³¹

In South America, as in Australia, it is likely that numerosity has been of relatively low importance to many groups, as evidenced by the low limits to underived “atoms” in three-fourths of the languages surveyed, the existence of vague or ambiguous terms (though these are far fewer than those attested in Australia), and the low overall limits in over one-third of the languages sampled. A number of groups – most of which are agriculturally focused peoples, as opposed to hunter-gatherers – have nonetheless elaborated their numeral complexity, as can be seen in their higher upper limits, some layering of bases, and the frequency of derived terms for 5 and above. Some of this elaboration

31. The root **ma*:- ‘hand’ also occurs widely in Uto-Aztecan words for 5 and 10, but the full terms do not reconstruct except to the lowest levels of subgrouping.

and/or restructuring has involved contact with other groups – evidenced by calquing, e.g., of “relational” terms for 4, but only minimally by lexical borrowing; languages have also frequently used their own resources, as indicated by the high levels of etymological transparency in low-level numeral terms.

Numerals appear to have been widely present in the African languages. The opacity of low-level terms, general absence of vague/ambiguous terms, lack of much layering of bases, and high-limit systems in many languages suggest some time-depth (particularly for low-level numerals) and do not point to a particularly recent elaboration of the more complex systems. As noted above, several of the hunter-gatherer languages with low numeral system limits are related to other languages with much more extensive systems, in many cases spoken by agriculturalists/pastoralists (notably of the Bantu, Ubangian, and Khoe families); in the Bantu and Ubangian cases the hunter-gatherers have most likely experienced language shift at some time in the past. These facts raise the intriguing question of whether the agriculturalists’ systems were elaborated, or whether instead the hunter-gatherer systems underwent a reduction of complexity over time (i.e., atrophied due to lack of regular use). In the case of Bantu, synchronic and diachronic evidence support an earlier quinary counting system (synchronically, some languages like Chichewa use 5 as a base for numerals between 5 and 10, while others show that numerals 1 to 5 are a unified class morphosyntactically but numerals 6 to 10 behave differently; diachronically, only terms through 5 reconstruct for Proto-Bantu; see Zerbian & Krifka 2008, Meeussen 1967: 105), suggesting that the lower-limit systems in these hunter-gatherer languages may have simply avoided elaboration, while those of their agriculturalist neighbors were expanded. Further research into the histories of numeral terms in these languages will shed light on these questions.

Finally, while our Asian sample is much more limited, it suggests that numeral complexity is relatively well established among northeastern/Siberian hunter-gatherers (see also Hammarström 2008). The southeastern peoples surveyed have altered their systems almost entirely through contact; the extent to which these changes involved replacement or augmentation of prior systems is not known.

5. Conclusions

Numerals are unlike many other linguistic categories in that their complexity varies widely across languages, and they are prone to culturally facilitated elaboration. The extent to which this development of numeral complexity correlates with subsistence pattern and/or other sociocultural parameters has long been a matter of speculation.

This study contributes a neglected area to the discussion of numeral typology. In considering numeral systems across 193 hunter-gatherer languages, dis-

tributed across multiple continents, we observe that hunter-gatherer numerals vary widely on a number of parameters. Hunter-gatherer systems are by no means always small and simple; nor, when we compare the numeral systems of neighboring agriculturally focused peoples, do we find that these are always complex. Similarly, even restricted systems (like those common in Australia and South America) are diverse in their possibilities for numeral formation (see also Bower & Zentz 2011), with variation in relative productivity, bases used, and historical sources of terms. Patterns in numeral limits, values and multiplicity of bases, points of transition from “atomic” to derived numeral terms, etymological transparency in low-level terms, and proportions of loans tend to correspond primarily to large-scale geographic region, although there is considerable variation within these regions as well.

The variation across hunter-gatherer numeral systems worldwide indicates that subsistence practice is not itself a predictor of numeral system type. Nevertheless, there is some indication that numeral complexity and subsistence pattern may be associated, if only weakly. Because of the strong areal component to numeral patterns, such a correlation is best looked for within, rather than across, geographical regions. This is impossible in Australia, which has no native agriculture. We also find no evidence of a correlation in California and the Great Basin (nor does one appear likely in Northeast Asia/Siberia; see also Hammarström 2008, Comrie 2011). In South America and Africa, on the other hand, we do see a tendency for hunter-gatherer numeral systems to be relatively small (i.e., to have low overall limits, and corresponding low uppermost bases), whereas larger systems are more likely to be encountered among languages spoken by more agriculturally oriented peoples. However, restricted systems are also widespread among agriculturalist groups in South America (who typically practice some hunting and gathering as well); the small number of “pure” hunter-gatherer languages in this region – of which several are genetically related – makes it difficult at this point to establish whether a significant correlation exists.

The areality of numeral patterns, as well as the visible effects of contact in many systems (loanwords, calquing, etc.), suggests that hunter-gatherer numerals regularly experience changes motivated by neighboring systems, including those of agriculturalists. It is therefore intriguing that two regions of the world in which a particularly strong hunting-gathering focus exists – Australia, which has no native agriculture, and South America (particularly the Amazon basin), where most groups typically practice some mix of hunting, gathering, and agriculture – both exhibit a broad regional tendency toward restricted numeral systems, and that in South America this tendency is particularly prevalent among the more “pure” hunter-gatherers (as is also true for Africa). It is likewise intriguing that it is Australia, where virtually no contact with agriculturalist languages took place before European arrival, where restricted numeral systems

are practically universal. We therefore emphasize the possibility that, despite the enormous variation among numerals in contemporary hunter-gatherer languages, such restricted systems were much more common throughout most of human history.

In conclusion, the richness of numeral systems around the globe, and their relationship to human experience and cognition, can only be understood if we consider a full range of languages, spoken in diverse parts of the world and by peoples that have often been overlooked by science.

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Appendix: Languages and data sources

For each language in our sample, information is given on its genetic affiliation, the subsistence focus of the speaker community, and the language data sources used. Three subsistence foci are distinguished: HG (hunter-gatherer), AG (agriculturalist), and MX (mixed subsistence). See Section 2 above for discussion of how these categorizations are defined. Information about subsistence focus comes from a variety of ethnographic sources (including Olson 1991 and personal knowledge of the authors for South America; for North America, articles in D'Azavedo (ed.) 1986, Ortiz (ed.) 1986, and Kroeber 1925). The data are

arranged geographically, starting with Australia, followed by California/Great Basin, South America, Africa, and finally Asia.

Table A-1. *Australia*

Language	Language family	Subsistence focus	Sources of data
Bunuba	Bunuban	HG	Rumsey (2000)
Gooniyandi	Bunuban	HG	McGregor (1988, 1990, 2004)
Garrwa	Garrwan	HG	Breen (2003), Furby et al. (no date), Furby & Furby (1977, no date)
Wanyi	Garrwan	HG	Breen (2003)
Kajirrabeng	Jarragan	HG	Nekes & Worms (2006)
Kija	Jarragan	HG	Blythe (2001)
Miriwoong	Jarragan	HG	Kofod (1976), Nekes & Worms (2006)
Jingulu	Mirndi	HG	Nekes & Worms (2006)
Wambaya	Mirndi	HG	Nordlinger (1998)
Bardi	Nyulnyulan	HG	Bowern (forthcoming)
Jabirr-Jabirr	Nyulnyulan	HG	Nekes & Worms (2006)
Jawi	Nyulnyulan	HG	Nekes & Worms (2006)
Ngumbarl	Nyulnyulan	HG	Nekes & Worms (2006)
Nimanburru	Nyulnyulan	HG	Nekes & Worms (2006)
Nyikina	Nyulnyulan	HG	McGregor (2004), Nekes & Worms (2006)
Nyulnyul	Nyulnyulan	HG	Nekes & Worms (2006)
Warrwa	Nyulnyulan	HG	McGregor (2004)
Yawuru	Nyulnyulan	HG	Nekes & Worms (2006)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Adnyamathanha	Pama-Nyungan	HG	McEntee & McKenzie (1992), O'Grady (no date), O'Grady & Kloveid (1969), Sommer (1967)
Adnyamathanha (Wonoka)	Pama-Nyungan	HG	W. Green (1886b)
Arabana	Pama-Nyungan	HG	Hercus (1994)
Arabana (Peake Telegraph Station)	Pama-Nyungan	HG	Todd (1886)
Arabana (Strangway Springs)	Pama-Nyungan	HG	Warren (1886)
Arabana (Wangkalyaka)	Pama-Nyungan	HG	Jacobs (1886c)
Arabana (West of Lake Eyre)	Pama-Nyungan	HG	Warren & Hogarth (1886)
Arabana-Wangkangurru (Arabana)	Pama-Nyungan	HG	Hercus (1989), Reuther (1973)
Birlinarra	Pama-Nyungan	HG	Nordlinger & Jones (no date)
Bularnu	Pama-Nyungan	HG	Breen (1988)
Deniliquin	Pama-Nyungan	HG	G. Gordon (1886)
Dhangu	Pama-Nyungan	HG	Schebeck (1973)
Dhuwal (Djapu)	Pama-Nyungan	HG	Morphy (1983)
Dhuwala (Gupapuyngu)	Pama-Nyungan	HG	Lowe (1996), Zorc (1986)
Diyari	Pama-Nyungan	HG	Austin (1981), Howitt (1886), Reuther (1973)
Djinaj	Pama-Nyungan	HG	Waters (1988)
Gamilaraay	Pama-Nyungan	HG	Ash et al. (2003), Austin (1992), Nekes & Worms (2006)
Gamilaraay (Barraba)	Pama-Nyungan	HG	Bench of Magistrates at Barraba (1886)
Gamilaraay (Bogabrie)	Pama-Nyungan	HG	Bench of Magistrates at Bogabrie (1886)
Gamilaraay (Kamilaroi Station)	Pama-Nyungan	HG	Curr (1886)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Gamilaraay (Kamilaroi)	Pama-Nyungan	HG	Mathews (1903), Ridley (1875)
Gamilaraay (Moree)	Pama-Nyungan	HG	Bench of Magistrates at Moree (1886)
Gamilaraay (Namoi)	Pama-Nyungan	HG	Bench of Magistrates at Wee-waa (1886)
Gamilaraay (Nundle)	Pama-Nyungan	HG	Bench of Magistrates at Nundle (1886)
Gurindji	Pama-Nyungan	HG	Patrick McConvell (personal communication); McGregor (2004), McNair & McNair (no date), McNair et al. (1981)
Gurindji (Mallee Cliffs Station to Wentworth)	Pama-Nyungan	HG	McFarlane (1886)
Jaru	Pama-Nyungan	HG	Nekes & Worms (2006), Tsunoda & Hudson (1981)
Jiwaliny	Pama-Nyungan	HG	Hale (1982)
Karajarri	Pama-Nyungan	HG	Laves (1929–1932), McKelson (1989), Nekes & Worms (2006)
Kurna	Pama-Nyungan	HG	Amery & Simpson (1994); Nekes & Worms (2006); Teichelmann & Schürmann (1840, 1967); Teichelmann, Schürmann & Wyatt (1886)
Kurna (Simpson)	Pama-Nyungan	HG	Teichelmann, Schürmann & Simpson (1990)
Kukatja	Pama-Nyungan	HG	Nekes & Worms (2006), Peile (1990), (1993)
Kungkari	Pama-Nyungan	HG	Breen (1990), Holmer (1988), Tindale 1940

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Kuyani	Pama-Nyungan	HG	Kingsmill (1886), O'Grady & Klokeid (1969)
Kuyani (Eastern Shore of Lake Torrens)	Pama-Nyungan	HG	W. Green (1886a)
Malngin	Pama-Nyungan	HG	McConvell (1981)
Mangarla	Pama-Nyungan	HG	McKelson (1988), Nekes & Worms (2006)
Northern Mangarla	Pama-Nyungan	HG	O'Grady (1967a)
Martu Wangka	Pama-Nyungan	HG	Marsh (1992)
Mithaka	Pama-Nyungan	HG	Austin (1991), Breen (1968, fieldnotes)
Mudburra	Pama-Nyungan	HG	Breen (1991), R. Green (no date), Patrick McConvell (personal communication), McConvell & Nash (1984)
Mulyara	Pama-Nyungan	HG	Gifford (1886)
Muruwari	Pama-Nyungan	HG	Nekes & Worms (2006), Oates (no date a, b)
Narangga	Pama-Nyungan	HG	Black (1920), Narangga Aboriginal Progress Association (2006)
Narangga (Yorke's Peninsula)	Pama-Nyungan	HG	Kühn (1886)
Ngaanyatjarra/ Ngaatjatjarra	Pama-Nyungan	HG	Glass (1988), Glass & Hackett (2003)
Ngamini	Pama-Nyungan	HG	Breen (1967), Reuther (1973)
Ngamini (Kopperamana)	Pama-Nyungan	HG	Jacobs (1886a)
Ngarinyman	Pama-Nyungan	HG	Jones (2005)
Ngiyampaa	Pama-Nyungan	HG	Honery (1877–1878), Mathews (1902)
Ngulupulu	Pama-Nyungan	HG	Machattie & Little (1886)
Nhirrpi	Pama-Nyungan	HG	Bowern (1999)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Nukunu	Pama-Nyungan	HG	Hercus (1992), Valentine (1886)
Nyangumarta	Pama-Nyungan	HG	Geytenbeek & Geytenbeek (1991), Strelley School & PALC (no date), B. Thomas et al. (1990)
Parnkala	Pama-Nyungan	HG	Le Souef & Holden (1886), Nekes & Worms (2006), Schürmann (1844, 1967)
Parnkala (Gawler Range)	Pama-Nyungan	HG	Sawers (1886)
Pirriya	Pama-Nyungan	HG	Breen (1990), Tindale (1940)
Pitjantjatjara/ Yankunytjatjara	Pama-Nyungan	HG	Goddard (1987, 1992, 1996), J. Green (2003)
Pitta-Pitta	Pama-Nyungan	HG	Austin (1990), Blair (1886), Blake (1979)
Punthamara	Pama-Nyungan	HG	Holmer (1988)
Ringu Ringu	Pama-Nyungan	HG	Craigie (1886), McLean (1886)
Ritharrngu	Pama-Nyungan	HG	Heath (1980)
Wakaya	Pama-Nyungan	HG	Breen (1981a, b, 1985–1986)
Walmajarri	Pama-Nyungan	HG	Amery & Hudson (1981), J. Green (2003), Hudson & Richards (1981, no date), Nekes & Worms (2006), Richards & Hudson (1990)
Wangka	Pama-Nyungan	HG	Blythe (2000)
Wangkangurru	Pama-Nyungan	HG	Reuther (1973)
Wangkangurru (Warburton River)	Pama-Nyungan	HG	Cornish (1886b), Paull (1886)
Wangkayutyuru	Pama-Nyungan	HG	Blake (no date)
Wangkumara	Pama-Nyungan	HG	Robertson (1984)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Wangkumara (Cooper's Creek)	Pama-Nyungan	HG	Sullivan & Eglinton (1886)
Wangkumara (Garlali)	Pama-Nyungan	HG	McDonald & Wurm (1980)
Wangkumara (Nockatoonga)	Pama-Nyungan	HG	T. Foott (1886)
Wangkumara (Thargominda)	Pama-Nyungan	HG	Myles (1886)
Warlmanpa	Pama-Nyungan	HG	Nash & Hale (1979–1984, 1981)
Warlpiri	Pama-Nyungan	HG	Hale (1967, 1995, personal communication to Barry Alpher), Swartz (1996)
Warluwarra	Pama-Nyungan	HG	Breen (1971, no date)
Warnman	Pama-Nyungan	HG	Thieberger & Taylor (1987), Wangka Maya et al. (1991)
Warumungu	Pama-Nyungan	HG	Disbray (2005), Simpson (2002), Simpson & Heath (1982)
Wayilwan (Brewarrina and Barwan River)	Pama-Nyungan	HG	Bench of Magistrates at Brewarrina (1886)
Wayilwan (Culgoa River)	Pama-Nyungan	HG	J. Foott (1886)
Wiradjuri	Pama-Nyungan	HG	Hosking & McNicol (1992)
Wiradjuri (Carcoar)	Pama-Nyungan	HG	Bench of Magistrates at Bathurst (1886a)
Wiradjuri (Dubbo)	Pama-Nyungan	HG	Bench of Magistrates at Dubbo (1886)
Wiradjuri (Hill End)	Pama-Nyungan	HG	Bench of Magistrates at Bathurst (1886b)
Wiradjuri (Sources of Bogan River)	Pama-Nyungan	HG	Bench of Magistrates at Obley (1886)
Wiradjuri (Wiradhurri)	Pama-Nyungan	HG	Larmer (1898), Schmidt (1919)
Wirangu	Pama-Nyungan	HG	Hercus (1999), O'Grady (1967b)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Wirangu (Streaky Bay)	Pama-Nyungan	HG	Provis (1886), Richardson (1886)
Yan-nhangu	Pama-Nyungan	HG	Bowern (fieldnotes)
Yandruwandha	Pama-Nyungan	HG	Austin (1991), Breen (2004), Reuther (1973)
Yandruwandha (Cooper's Creek)	Pama-Nyungan	HG	Cornish (1886a), Salmon (1886)
Yanyuwa	Pama-Nyungan	HG	Bradley (1992)
Yarluyandi	Pama-Nyungan	HG	Austin (1991), Hercus (no date)
Yarluyandi (North Shore of Lake Eyre)	Pama-Nyungan	HG	Jacobs (1886b)
Yawarrawarrka	Pama-Nyungan	HG	Austin (1991), Reuther (1979)
Yulparija	Pama-Nyungan	HG	McKelson (1988–1989), O'Grady (1967c)
Yuwaalaraay	Pama-Nyungan	HG	Ash et al. (2003), Nekes & Worms (2006), Williams (1980)
Yuwaaliyaay (Balonne, Nerran)	Pama-Nyungan	HG	Hammond (1886)
Yuwaaliyaay (Yuwaalayaay)	Pama-Nyungan	HG	Ash et al. (2003)
Ngarinyin	Wororan	HG	McGregor (1992), McGregor & Rumsey (2009)
Unggumi	Wororan	HG	McGregor (1992), McGregor & Rumsey (2009)
Worrorra	Wororan	HG	Clendon (2000a, b), Love (2000), McGregor (1992), McGregor & Rumsey (2009), Nekes & Worms (2006)
Yawijibaya	Wororan	HG	McGregor (1992), McGregor & Rumsey (2009)

Australia (cont.)

Language	Language family	Subsistence focus	Sources of data
Wardaman	Yangmanic	HG	Merlan (1994), Morphy (1983)

Table A-2. *California/Great Basin*

Language	Language family	Subsistence focus	Sources of data
Wintu	“Penutian”	HG	Pitkin (1985)
Chumash Obispeño 1832	Chumashan	HG	Beeler (1964: 12), Klar (1980)
Chumash Barbareño 1832	Chumashan	HG	Beeler (1964: 12), Dixon & Kroeber (1907: 682)
Chumash Ventureño	Chumashan	HG	Beeler (1964: 15–16)
Chumash Ineseño	Chumashan	HG	Kroeber (1910: 267)
Chumash Isleño	Chumashan	HG	Dixon & Kroeber (1907: 682)
Seri/Comcaac	Isolate	HG	Moser & Marlett (1997, 2005)
Esselen	Isolate	HG	Shaul (1995), Dixon & Kroeber (1907: 683)
Zuni	Isolate		Newman (1958)
Salinan Antoniaño	Isolate	HG	Turner (1987: 174), Mason (1918)
Washo	Isolate	HG	The Washo Project (http://washo.uchicago.edu/)
Santa Ana Keres	Keresan (Eastern)	AG	Davis (1964)
Acoma Keres	Keresan (Western)	AG	W. Miller (1965)
Laguna Keres	Keresan (Western)	AG	Lachler (2006)
Tewa (Rio Grande, San Ildefonso)	Kiowa-Tanoan	AG	Harrington (1909)
Jemez Towa	Kiowa-Tanoan	AG	Harrington (1909)
Northern Tiwa (Piro)	Kiowa-Tanoan	AG	Harrington (1909)
Southern Tiwa (Isleta)	Kiowa-Tanoan	AG	Harrington (1909)
Northern Tiwa (Taos)	Kiowa-Tanoan	AG	Harrington (1910), Trager (1946)

California/Great Basin (cont.)

Language	Language family	Subsistence focus	Sources of data
Gabrielino/Tongva	Uto-Aztecan	HG	Harrington (notes), McCawley (1996 for Merriam notes)
Southern Ute	Uto-Aztecan	MX	Givón (1980: 34)
Tümpisa Shoshone	Uto-Aztecan	HG	Dayley (1989: 161)
Big Smokey Valley Shoshoni	Uto-Aztecan	HG	Crapo (1976: 18)
Tohono O'odham	Uto-Aztecan	AG	Zepeda (1983), Saxton et al. (1983)
Cahuilla	Uto-Aztecan	MX	Seiler (1977: 330–335), Seiler & Hioki (1979)
Cupeño	Uto-Aztecan	HG	Hill & Nolasquez (1973), J. Hill (2005)
Luißeño	Uto-Aztecan	HG	Kroeber & Grace (1960: 118)
Southern Paiute	Uto-Aztecan	MX	Sapir (1930: 262)
Northern Paiute	Uto-Aztecan	MX	Snapp et al. (1982: 50), Thorne (2003: 211–214 for above 10)
Comanche	Uto-Aztecan	MX	Charney (1993: 160)
Western Mono	Uto-Aztecan	HG	Lamb (1957: 218–219), Bethel et al. (eds.) (1993)
Kawaiisu	Uto-Aztecan	HG	Zigmond et al. (1991: 65)
Kitanemuk	Uto-Aztecan	HG	Anderton (1988)
Hopi	Uto-Aztecan	AG	Hopi Dictionary Project (1998)
Tübatulabal	Uto-Aztecan	HG	Voegelin (1935), K. Hill (2009)
Serrano	Uto-Aztecan	HG	Kenneth C. Hill (field notes)
Chemehuevi	Uto-Aztecan	AG	Press (1979)
Southern Sierra Miwok	Yok-Utian	HG	Broadbent (1964)
Northern Sierra Miwok	Yok-Utian	HG	Callaghan (1987)
Central Sierra Miwok	Yok-Utian	HG	Freeland & Broadbent (1960)
Lake Miwok	Yok-Utian	HG	Callaghan (1958, 1965)

California/Great Basin (cont.)

Language	Language family	Subsistence focus	Sources of data
Plains Miwok	Yok-Utian	HG	Callaghan (1984)
Mutsun	Yok-Utian	HG	Okrand (1977), Dixon & Kroeber (1907: 683, Costanoan of San Juan Bautista)
Yokuts (Yowlumne)	Yok-Utian	HG	Newman (1944: 55)
Yokuts (Yawdanchi)	Yok-Utian	HG	Kroeber (1963)
Yokuts (Palewyami)	Yok-Utian	HG	Kroeber (1963)
Nisenan	Yok-Utian	HG	Uldall & Shipley (1966)
Maidu	Yok-Utian	HG	Shipley (1963)
Wappo	Yukian	HG	Sawyer (1965)
Yuki	Yukian	HG	Sawyer & Schlichter (1984), Dixon & Kroeber (1907)
Mojave A	Yuman	AG	Langdon & Munro (1980: 124), Munro et al. (1993)
Mojave C	Yuman	AG	Langdon & Munro (1980: 124), Munro et al. (1993)
Yavapai	Yuman	AG	Kendall (1977), Langdon & Munro (1980: 124)
Kiliwa	Yuman	HG	Langdon & Munro (1980: 124), Mixco (1985)
Cocopa	Yuman	AG	Langdon & Munro (1980: 124), Crawford (1989)

Table A-3. *South America*

Language	Language family	Subsistence focus	Sources of data
Yuma	Yuman	AG	Langdon & Munro (1980: 124)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Iipay Aa	Yuman	HG	Langdon & Munro (1980: 124), Couro & Langdon (1975), Couro & Hutcheson (1973)
Kulina	Arawá	AG	D. Green (1997: 4), Dixon (2004a)
Wapishana	Arawak	AG	Chan (1998–2001, from Daws & Hicks), Santos (2006: 118)
Yucuna	Arawak	AG	Schauer (ed.) (2005)
Bare	Arawak	AG	Aikhenvald (1995)
Baniwa	Arawak	AG	Ramirez (2001), Huber & Reed (1992)
Resígaro	Arawak	AG	Allin (1979)
Tariana	Arawak	AG	Aikhenvald (2003: 217–219)
Paresi	Arawak	AG	Ana Paula Brandão (field notes)
Warekena	Arawak	AG	Aikhenvald (1998: 298–299, 312–313)
Baure	Arawak	AG	Danielsen (2007)
Ignaciano	Arawak	AG	Chan (1998–2011, from Ott)
Kampa	Arawak	AG	D. Green (1994)
Terena	Arawak	AG	Ekdahl & Butler (1969)
Matsiguenga	Arawak	AG	Snell (ed.) (1998)
Cabiyarí	Arawak	AG	Huber & Reed (1992)
Apurinã	Arawak	AG	Facundes (2000: 359)
Kurripaco	Arawak	AG	Valadares (1994)
Piapoco	Arawak	AG	Klumpp (1995), Huber & Reed (1992)
Wayuu/Guajiro	Arawak	AG	Captain & Captain (2005)
Chamikuro	Arawak	AG	Parker (ed.) (1995)
Piro	Arawak	AG	Matteson (1965: 107)
Palikúr	Arawak	AG	D. Green (1994, 1997)
Arawak/Lokono	Arawak	AG	Bennett (1994), Pet (1987: 87–88)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Achagua	Arawak	AG	Huber & Reed (1992), Meléndez (1998: 83–90)
Amuesha	Arawak	AG	Chan (1998–2011, from Daigneault)
Asheninca	Arawak	MX	Mihas (2010)
Waurá	Arawak	MX	Chan (1998–2011, from Richards)
Iñapari	Arawak	HG	Parker (ed.) (1995)
Southern Aymara	Aymara	AG	Pilares (2005)
Central Aymara	Aymara	AG	Pilares (2005)
Awa	Barbacoa	AG	Huber & Reed (1992), Curnow (1997)
Tsafiqui pila	Barbacoa	AG	Huber & Reed (1992)
Totoró	Barbacoa	AG	Huber & Reed (1992)
Guambiano	Barbacoa	AG	Huber & Reed (1992)
Cha'palaachi	Barbacoa	MX	Huber & Reed (1992)
Bora	Bora	MX	Aschmann (1993: 142–143), Thiesen & Thiesen (1998)
Miraña	Bora	MX	Seifart (2005: 130–132)
Muinane	Bora	MX	Aschmann (1993: 142–143)
Ikpeng	Carib	AG	Scanduzzi (2008: 80–87)
Hixkaryana	Carib	AG	Derbyshire (1979)
Bakairí	Carib	AG	D. Green (1997: 6)
Makuxi	Carib	AG	Abbott (1991)
Kalapalo	Carib	AG	Scanduzzi (2008: 80–86)
Kuikuro	Carib	AG	Scanduzzi (2008: 80–85)
Akawaio	Carib	AG	Chan (1998–2011, from Stegeman)
Galibi	Carib	AG	Chan (1998–2001, from Ziel)
Apalai	Carib	AG	Koehn & Koehn (1995)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Waiwai	Carib	MX	Chan (1998–2011, from Hemmauer)
Trió	Carib	MX	Chan (1998–2011, from Wilner)
Carijona	Carib	MX	Huber & Reed (1992)
Waimiri-Atroari	Carib	MX	D. Green (1997: 6–7)
Arára	Carib	MX	D. Green (1997: 6–8), Costa de Souza (1995: 2–3)
Yukpa	Carib	MX	Huber & Reed (1992)
Dimina	Chibcha	AG	Huber & Reed (1992)
Ika	Chibcha	AG	Huber & Reed (1992)
Kogui	Chibcha	AG	Huber & Reed (1992)
Barí	Chibcha	MX	Huber & Reed (1992)
Chimila	Chibcha	MX	Huber & Reed (1992)
Tunebo	Chibcha	MX	Huber & Reed (1992)
Wounaan	Chocó	AG	Huber & Reed (1992)
Basurudó	Chocó	MX	Huber & Reed (1992)
Catío	Chocó	MX	Huber & Reed (1992)
Darién	Chocó	MX	Huber & Reed (1992)
Saija	Chocó	MX	Huber & Reed (1992)
Tadó	Chocó	MX	Huber & Reed (1992)
Chamí	Chocó	MX	Huber & Reed (1992)
Guayabero	Guahibo	MX	Huber & Reed (1992)
Cuiba	Guahibo	HG	Huber & Reed (1992)
Jitnu	Guahibo	HG	Huber & Reed (1992)
Playero	Guahibo	HG	Huber & Reed (1992)
Guahibo	Guahibo	HG	Huber & Reed (1992)
Kadiwéu	Guaikurú	AG	D. Green (1997: 3, 11)
Trumai	Isolate	AG	Guirardello (1999: 47)
Movima	Isolate	AG	Haude (2006)
Ticuna	Isolate	AG	Anderson (1962)
Páez	Isolate	AG	Huber & Reed (1992)
Camsá	Isolate	AG	Huber & Reed (1992)
Warao	Isolate	AG	Chan (1998–2011, from Romero-Figueira)
Urarina	Isolate	MX	Olawsky (2006)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Taushiro	Isolate	MX	Chan (1998–2011, from Alicea)
Andoke	Isolate	MX	Landaburu (1979)
Hoti	Isolate	HG	Marie-Claude Mattei Müller (word list)
Yaámana (Yaghan)	Isolate	HG	Chan (1998–2011, from Aguilera)
Huaorani	Isolate	HG	Chan (1998–2011, from Peeke)
Wansōjōt/Puinave	Isolate/Unclassified	AG	Huber & Reed (1992), Chan (1998–2011, from Girón)
Kwaza	Isolate	MX	van der Voort (2006)
Kakua	Kakua-Nukak	HG	Huber & Reed (1992), Katherine Bolaños (field notes)
Nukak	Kakua-Nukak	HG	Huber & Reed (1992)
Boróro	Macro-Je, Boróro	MX	D. Green (1997: 5), Crowell (1979: 218–219)
Maxacalí	Macro-Je, Maxacalí	MX	D. Green (1997: 6), Popovich & Popovich (2005)
Djeoromitxí	Macro-Je, Jabutí	MX	Chan (1998–2011, from van der Voort)
Guató	Macro-Je, Guató	MX	Chan (1998–2011, from Palácio)
Xavánte	Macro-Je, Je	MX	D. Green (1997: 5), McLeod & Mitchell (1977)
Xerénte	Macro-Je, Je	MX	Melo (2007: 104), D. Green (1997: 5)
Suyá/Kisêdjê	Macro-Je, Je	MX	Chan (1998–2011, from Nonato)
Canela	Macro-Je, Je	MX	D. Green (1997: 3), Popjes & Popjes (1986)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Kayapó	Macro-Je, Je	MX	D. Green (1997: 5, 7); Chan (1998–2011, from Thomson)
Apinayé	Macro-Je, Je	MX	Chan (1998–2011, from Ham)
Karajá	Macro-Je, Karajá	MX	Chan (1998–2011, from Rozende and Fortune)
Kipeá	Macro-Je, Karirí	MX	Mamiani (1877: 6)
Pirahã	Mura	HG	Everett (1992: 353, 2005)
Dâw	Nadahup	HG	Martins (2004)
Hup	Nadahup	HG	Epps (2006, 2008)
Yuhup	Nadahup	HG	Ospina (2002)
Nadëb	Nadahup	HG	Weir (1984)
Sabanê	Nambikwara	MX	Antunes de Araujo (2004)
Katukina	Panoan	AG	Amarante & Cândido (2005: 101, 105)
Kapanawa	Panoan	AG	Amarante & Cândido (2005: 101, 105)
Yaminawa	Panoan	AG	Faust & Loos (2002), Amarante & Cândido (2005: 101, 105)
Amahuaca	Panoan	AG	Hyde (1980), Amarante & Cândido (2005: 101, 105)
Matses	Panoan	MX	Fleck (2003: 559–560)
Matis	Panoan	MX	Ferreira (2005: 194–196)
Shipibo-Conibo	Panoan	MX	Loriot et al. (1993)
Kashibo-Kakataibo	Panoan	MX	Amarante & Cândido (2005: 101, 105)
Kaxinawa/Cashinahua	Panoan	MX	Montag (2008), Amarante & Cândido (2005: 101, 105)
Sharanawa	Panoan	MX	Amarante & Cândido (2005: 101, 105)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Shanenawa	Panoan	MX	Cândido (2004: 139–142)
Yagua	Peba-Yagua	MX	Powlison & Powlison (1958), Powlison (1995)
Incahuasi	Quechua	AG	Pilares (2005)
Imbabura Highland Quichua	Quechua	AG	Chan (1998–2011, from Floyd)
Quechua de Cusco	Quechua	AG	Chan (1998–2011, from Phelps)
Salasaca Quichua	Quechua	AG	Chan (1998–2011)
Southern Pastaza Quechua	Quechua	AG	Chan (1998–2011, from Tödter)
Tena Quichua	Quechua	AG	Chan (1998–2011, from Orr)
Inga	Quechua	AG	Levinsohn (1976)
Ancash	Quechua	AG	Pilares (2005)
Ayachucho	Quechua	AG	Pilares (2005)
Cuzco Collao	Quechua	AG	Pilares (2005)
Huallaga	Quechua	AG	Pilares (2005)
Junín	Quechua	AG	Pilares (2005)
Lamas	Quechua	AG	Pilares (2005)
Napo	Quechua	AG	Pilares (2005)
Sáliba	Sáliba-Piaroa	MX	Huber & Reed (1992)
Ese Ejja	Tacanan	AG	Vuillermet (in preparation)
Bará/Waimaja	Tukanoan, E.	AG	Huber & Reed (1992)
Barasano	Tukanoan, E.	AG	Huber & Reed (1992)
Karapana (Carapana)	Tukanoan, E.	AG	Huber & Reed (1992)
Tatuyo	Tukanoan, E.	AG	Huber & Reed (1992)
Tukano	Tukanoan, E.	AG	Huber & Reed (1992), Ramirez (1997)
Tuyuka	Tukanoan, E.	AG	Huber & Reed (1992)
Yurutí	Tukanoan, E.	AG	Huber & Reed (1992)
Macuna	Tukanoan, E.	AG	Huber & Reed (1992)
Waikhana/Piratapuyo	Tukanoan, E.	AG	Huber & Reed (1992)
Siriano	Tukanoan, E.	AG	Huber & Reed (1992)
Kotiria/Wanano	Tukanoan, E.	AG	Stenzel (2004: 185–191)
Retuarã/Tanimuca	Tukanoan, E.	AG	Strom (1992)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Kubeo	Tukanoan, E.	MX	Morse & Maxwell (1999)
Desano	Tukanoan, E.	MX	M. Miller (1999: 46–47)
Siona	Tukanoan, W.	AG	Wheeler (1970)
Koreguaje	Tukanoan, W.	AG	Cook & Gralow (2001)
Secoya	Tukanoan, W.	AG	Huber & Reed (1992)
Orejon	Tukanoan, W.	AG	Velie & Velie (1981)
Mundurukú	Tupí	AG	D. Green (1997: 8–9)
Kamaiurá	Tupí	AG	Seki (2000)
Tapirape	Tupí	AG	Praça (2007: 149–151)
Karo	Tupí	AG	Gabas (1999: 65)
Karitiana	Tupí	AG	C. Everett (2006)
Aweti	Tupí	AG	Chan (1998–2011, from Drude)
Satereé-Maweeé	Tupí	AG	Chan (1998–2011, from Pereira da Silva)
Gavião	Tupí	MX	Moore (1984)
Suruií	Tupí	MX	Chan (1998–2011, from Dietrich)
Asuriní do Xingú	Tupí, Tupí-Guaraní	AG	Nicholson (1982: 29–30, 71–72)
Asuriní do Trocará	Tupí, Tupí-Guaraní	MX	Nicholson (1982: 29–30)
Cocama-Cocamilla	Tupí, Tupí-Guaraní	AG	Chan (1998–2011, from Vallejos)
Guajábara	Tupí, Tupí-Guaraní	AG	D. Green (1997: 5), Chan (1998–2011, from da Silva)
Tupínambá	Tupí, Tupí-Guaraní	AG	Lemos Barbosa (1956)
Kayabí	Tupí, Tupí-Guaraní	AG	D. Green (1997: 5), Chan (1998–2011, from Dobson and Dietrich)
Wayampi	Tupí, Tupí-Guaraní	AG	D. Green (1997: 5)
Guaraní	Tupí, Tupí-Guaraní	AG	Dooley (1982)
Akwere	Tupí, Tupí-Guaraní	AG	D. Green (1997: 5)

South America (cont.)

Language	Language family	Subsistence focus	Sources of data
Tembé	Tupí, Tupí-Guaraní	MX	D. Green (1997: 5), Chan (1998–2011, from Dietrich)
Parakanã	Tupí, Tupí-Guaraní	MX	Chan (1998–2011, from Caetana Souza)
Omagua	Tupí, Tupí-Guaraní	MX	Lev Michael (personal communication)
Tenharim	Tupí, Tupí-Guaraní	MX	D. Green (1997: 4)
Murui Huitoto	Witotoan	MX	Aschmann (1993: 142–143), Burtch (1983)
Minica Huitoto	Witotoan	MX	Aschmann (1993: 142–143), Minor & Minor (1987)
Nipode Huitoto	Witotoan	MX	Aschmann (1993: 142–143), Minor & Minor (1971)
Ocaina	Witotoan	MX	Aschmann (1993: 142–143), Leach (1969)
Ninam	Yanomam	HG	Gomez (1990: 121–122), Migliazza (1972)
Sanumá	Yanomam	HG	Migliazza (1972), D. Green (1997: 4), Borgman (1990: 152)
Yanomami	Yanomam	HG	Mattei-Müller & Serowèe (2007)
Yanomamo	Yanomam	HG	Migliazza (1972)
Iquito	Zaparoan	AG	Hansen (2007)
Záparo	Zaparoan	AG	Peeke (1991: 62)
Arabela	Zaparoan	MX	Rich (1999)

Table A-4. *Africa*

Language	Language family	Subsistence focus	Sources of data
Tikar/Bedzan	Bantoid	AG [+HG]	Stanley (1986)
Akoose	Bantu A10	AG	Hedinger (2008)

Africa (cont.)

Language	Language family	Subsistence focus	Sources of data
Gyele/Kola	Bantu A80	HG	Chan (1998–2011, from Ngue Um)
Kakɔ	Bantu A90	AG	Ernst (ed.) (1989)
Tsogo/Bongo	Bantu B30	AG [+HG]	Raponda-Walker (1996)
Teke/Bongo	Bantu B70	AG [+HG]	Etsio (1999)
Bagandou Aka	Bantu C10	HG	Thomas et al. (eds.) (1981–present)
Bayanga Aka	Bantu C10	HG	Thomas et al. (eds.) (1981–present)
Mongoumba Aka	Bantu C10	HG	Thomas et al. (eds.) (1981–present)
Lingala	Bantu C40	AG	Pashi & Turnbull (1994)
Rumanyo (Gciriku)	Bantu K70	MX	Möhlig & Shiyaka-Mberema (2005)
Herero	Bantu R30	AG	Viljoen & Kamupingene (1983)
Tswana	Bantu S30	AG	Lukusa & Monaka (2008)
Kgalagadi	Bantu S30	MX	Matumo (1993)
Lese/Efe	Central Sudanic	AG [+HG]	Vorbichler (1965)
Dahalo	Cushitic	HG	Tosco (1991)
Jara Boni	Cushitic	HG	Heine (1982)
Kilii Boni	Cushitic	HG	Heine (1982)
Waata	Cushitic	HG	Heine (1981)
Sandawe	Isolate	HG	Kagaya (1993)
Khoekhoegowab	Khoe	AG	Haacke & Eiseb (2002)
Kxoe	Khoe	HG	Kilian-Hatz (2003)
Naro	Khoe	HG	Visser (2001)
Gui	Khoe	HG	Tanaka & Sugawara (eds.) (2010)
ǁGana	Khoe	HG	Tanaka & Sugawara (eds.) (2010)
Ju 'hoan	Kx'a	HG	Dickens (1994)
Northwestern !Xun	Kx'a	HG	König & Heine (2008)
!Xoóoõ	Tuu	HG	Traill (1994)

Africa (cont.)

Language	Language family	Subsistence focus	Sources of data
Gbanziri	Ubangian	AG	Brisson & Boursier (1979), Brisson (1984)
Monzombo	Ubangian	AG	Calloc'h (1911)
Ngbaka	Ubangian	AG	Calloc'h (1911)
Baka	Ubangian	HG	Henrix et al. (2007)

Table A-5. *Asia*

Language	Language family	Subsistence focus	Sources of data
Agta (Casiguran Dumagat)	Austronesian	HG	Headland & Headland (1974: ii)
Jahai	Mon-Khmer, Aslian	HG	Burenhult (2005: 87)
Semelai	Mon-Khmer, Aslian	HG	Kruspe (2004)
Ainu	Isolate	HG	Hurford (1975: 239, citing Pott 1847: 86)
Nivkh	Isolate	HG	Gruzdeva (1998: 23–25)
Ket	Yeniseian	HG	Vajda (2004: 36)
Kolyma Yukaghir	Yukaghir	HG	Maslova (2003: 260)

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