

# The dying clicks of Yeyi

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## 1 Introduction

This paper discusses a number of points concerning the click sounds in the Bantu language Yeyi. Yeyi is notable in that it possesses the largest known click inventory of any Bantu language. The main obstacle confronting a study of Yeyi clicks is that the language is dying, and so no one speaker can be viewed as a representative consultant for phonetics. Fortunately, 13 speakers were recorded for phonetic analysis, which helps the enterprise greatly. This not only facilitates a more accurate description of the current state of clicks in the language, it also allows us to address two further points.

Following a general description of Yeyi clicks as we now find them, we examine the patterns of sound change which affect the clicks as a result of the language’s decline. Finally, we present a statistical study of the *duration* of the closure and release phases of the clicks, finding that these two acoustic correlates change with the various click accompaniments in largely expected ways, and more surprisingly, that together they can be used statistically to distinguish among the four places of articulation for clicks.

## 2 Background

### 2.1 Yeyi

Yeyi, also called Siyeyi or Sekoba, is a Bantu language with approximately 25 000 speakers remaining (Sommer and Voßen ). The speakers are concentrated in two areas of Africa, with the larger group living around the Okavango delta and along the Botletle river in a region of northwestern Botswana known as Ngamiland. The smaller group remains in their ancestral homeland of Diyeyi, located within Namibia’s Eastern Caprivi Strip. These two groups are thought to show some relatively minor dialectal differences (Gowlett ), and the data collected for this study comes entirely from Ngamiland speakers.

The language can fairly be considered as “dying”; there is no standard written form, and while Donnelly (1990) reports that the Caprivi speakers are maintaining their language, Sommer (1995) and Voßen (1988) have each stated that one third of the Ngamiland Yeyi have already given up their ancestral language in favor of Setswana, Botswana’s official language.

## 2.2 Clicks

A variety of terminology has been employed over the years in discussions of click phonetics; indeed, some terms have been used in precisely opposite ways in different reports. To help settle any such issues before we begin, we felt it prudent to specify how we will use the various terms and symbols for click sounds. Our conventions largely follow those found in Ladefoged and Maddieson (1996).

By the term *click* we mean a stop whose production involves a velaric ingressive airstream together with an accompanying velar or uvular consonant. The *place* of articulation of a click refers to the point of articulatory closure just prior to the moment of release (anterior to the necessary velar closure), except in the case of the term *lateral*, which then refers to an alveolar place of articulation that is laterally released. The *dental*, *alveolar*, *palatal*, and *lateral* places are symbolized by [!, †, ‡, ||] respectively. The convention of use here must be explicitly stated because the usage of the symbols [!, †] together with their defining terms has often been the reverse of ours. This is because if one focuses on the place of articulation well in advance of release, alveolar clicks seem to start out more retracted than palatal ones do although they are ultimately released further forward.

The *accompaniment* of a click refers to the accompanying velar (or uvular) consonant whose release just follows the click burst. Various velar consonant symbols will be used preceding the click sign itself to symbolize the accompaniments in fairly standard ways, and the resulting compound sound is the entire click sound.

## 3 Description of Yeyi clicks

### 3.1 Previous descriptions

Sommer and Voßen (1992) appears to be the only source containing any detailed discussion of the phonetics and phonology of Yeyi clicks. These authors identified four places of articulation and nine accompaniments (therein called *effluxes*) which Yeyi clicks may manifest. Not all combinations of these were attested, though. The complete inventory of clicks which these authors identified is given in Table 3.1, using the terminology of that paper. Most of these are justified as phonemic in that paper by some sort of minimal pair analysis. There are, however, several exceptions which they cannot justify as phonemic due to their infrequency, most notably both of the so-called uvular ejective clicks.

### 3.2 Data

Thirteen Yeyi (five women and eight men) were recorded each in a separate session under field conditions in Botswana for this study. The recordings were made on a Sony portable DAT machine at CD standard quality on August 4, 5, 8, and 9, 1998. The data on click

Table 1: Sommer and Voßen’s (1992) Yeyi click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>	k   <sup>h</sup>	k# <sup>h</sup>
voiceless uvular fricative release	k  <sup>ʁ</sup>			k# <sup>ʁ</sup>
voiceless	k	k!		k#
voiced	g	g!	g	
nasal	ŋg			ŋg#
nasal voiced	ŋ	ŋ!	ŋ	ŋ#
glottal stop	k  <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
uvular ejective	q  <sup>ʼ</sup>			q# <sup>ʼ</sup>
nasal ejective	ŋk  <sup>ʔ</sup>	ŋk! <sup>ʔ</sup>	ŋk   <sup>ʔ</sup>	ŋk# <sup>ʔ</sup>

sounds that we used was derived from a set of 47 Yeyi words that have in the past been found to contain clicks. The 13 speakers were each asked for three repetitions of each of the click words. All speakers knew most of the words and were able to speak examples, although only three of the speakers gave examples of all 47 click words. All recorded tokens were later digitized to sound files at a suitably high sampling rate using the Windows software PCQuirer on an Intel-compatible computer.

### 3.3 Click inventories

Examination of the thirteen speakers’ pronunciation of the sample click words reveals that twelve distinct inventories of clicks are employed. Only two speakers (8 and 9) use precisely the same inventory of click sounds in pronouncing the sample, and even they don’t use that inventory in identical ways (i.e. they still disagree on the pronunciation of certain words). Clearly the situation is not as neat as was implied in Sommer and Voßen (1992), and the sort of inventory given there (shown above) that is intended to represent the Yeyi language in general is not tenable. At this stage of language death, there simply is no “language in general,” especially not for that part of the phonology consisting of relatively rare sounds. Speaker 12’s inventory shows the greatest number of distinctly pronounced clicks, with 22. Speakers 5 and 7 each manifest the smallest number of clicks confirmed to be present in their inventories, with just 12.

In light of this new data, the Sommer and Voßen inventory requires revision on a number of points regarding the accompaniments.

- Working down from the top of their table, we should first note that the fricative released click, which we call *affricated*, is not necessarily uvular at all, but sounds like a velar

Table 2: Speaker 1 click inventory

	dental	alveolar	lateral	palatal
aspirated		k! <sup>h</sup>		k# <sup>h</sup>
affricated	k  <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!	ŋ	ŋ#
glottal	k  <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>			k# <sup>ʼ</sup>

Table 3: Speaker 2 click inventory

	dental	alveolar	lateral	palatal
aspirated	k! <sup>h</sup>	k! <sup>h</sup>		k# <sup>h</sup>
affricated	k  <sup>x</sup>			
plain	k	k!		
voiced	g	g!	g	g#
nasal	n	ŋ!	ŋ	ŋ#
glottal	k  <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>			k# <sup>ʼ</sup>

Table 4: Speaker 3 click inventory

	dental	alveolar	lateral	palatal
aspirated		k! <sup>h</sup>	k   <sup>h</sup>	k# <sup>h</sup>
affricated	k  <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!	ŋ	ŋ#
glottal	k  <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>			k# <sup>ʼ</sup>

Table 5: Speaker 4 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k <sup>h</sup>		k <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k <sup>l</sup>	k <sup>l</sup>		k <sup>h</sup>
voiced	g <sup>l</sup>	g <sup>l</sup>	g <sup>ll</sup>	g <sup>h</sup>
nasal	n <sup>l</sup>	ŋ <sup>l</sup>	ŋ <sup>ll</sup>	ŋ <sup>h</sup>
glottal	k <sup>ʔ</sup>	k <sup>ʔ</sup>		k <sup>ʔ</sup>
ejective	k <sup>ʼ</sup>			k <sup>ʼ</sup>

Table 6: Speaker 5 click inventory

	dental	alveolar	lateral	palatal
aspirated		k <sup>h</sup>		k <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k <sup>l</sup>	k <sup>l</sup>		
voiced	g <sup>l</sup>	g <sup>l</sup>	g <sup>ll</sup>	
nasal	n <sup>l</sup>	ŋ <sup>l</sup>		
glottal	k <sup>ʔ</sup>	k <sup>ʔ</sup>		

Table 7: Speaker 6 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k <sup>h</sup>	k <sup>ll</sup>	k <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k <sup>l</sup>	k <sup>l</sup>		
voiced	g <sup>l</sup>	g <sup>l</sup>	g <sup>ll</sup>	g <sup>h</sup>
nasal	n <sup>l</sup>	ŋ <sup>l</sup>		ŋ <sup>h</sup>
glottal	k <sup>ʔ</sup>	k <sup>ʔ</sup>		k <sup>ʔ</sup>
ejective	k <sup>ʼ</sup>			k <sup>ʼ</sup>

Table 8: Speaker 7 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>		
plain	k	k!		
voiced	g	g!		g#
nasal	n	ŋ!	ŋ	
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>		
ejective	(k  <sup>ʼ</sup> )			

Table 9: Speakers 8 and 9 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>		k# <sup>h</sup>
affricated	k  <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!		ŋ#
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective				k# <sup>ʼ</sup>
affricated ejective	k  <sup>xʼ</sup>			

Table 10: Speaker 10 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>	k   <sup>h</sup>	k# <sup>h</sup>
affricated	k  <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!		ŋ#
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>	k   <sup>ʔ</sup>	k# <sup>ʔ</sup>
affricated ejective	k  <sup>xʼ</sup>			

Table 11: Speaker 11 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>		k# <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!	ŋ	ŋ#
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>	k   <sup>ʔ</sup>	k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>			

Table 12: Speaker 12 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>	k   <sup>h</sup>	k# <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k	k!		k#
voiced	g	g!	g	g#
nasal	n	ŋ!	ŋ	ŋ#
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>	k! <sup>ʼ</sup>		k# <sup>ʼ</sup>

Table 13: Speaker 13 click inventory

	dental	alveolar	lateral	palatal
aspirated	k <sup>h</sup>	k! <sup>h</sup>		k# <sup>h</sup>
affricated	k <sup>x</sup>			
plain	k	k!	k	
voiced	g	g!		g#
nasal	n	ŋ!		ŋ#
glottal	k! <sup>ʔ</sup>	k! <sup>ʔ</sup>		k# <sup>ʔ</sup>
ejective	k  <sup>ʼ</sup>			k# <sup>ʼ</sup>

in most instances. It is probably just a phonetic variant of an aspirated click, as the only click of this sort in our data is a dental appearing in one word. In fact, there is no strong evidence of any kind of uvular clicks in Yeyi.

- There does not seem to be any linguistic reason to view the so-called “nasal” clicks as single speech sounds. They could be thought of as consonant clusters, in which a nasal precedes a voiced click, and we will from now on recognize only the one kind of nasal accompanied click which Sommer and Voßen call “nasal voiced.”
- The “uvular” ejective clicks seem to be velar clicks on these recordings, but we are able to demonstrate convincingly that the ejectives are indeed distinct from the velar clicks with glottal stop accompaniment. We refer to the latter as *glottalized*.
- There is again no reason to identify the “nasal ejective” clicks as segments in their own right; they are in fact clusters in which a nasal consonant precedes a glottalized click. All occurrences of the true ejective clicks in our data are not preceded by nasalization at all, while the glottalized clicks are usually, if not always, surrounded by nasalization (see appendix).
- Finally, it should be noted that three of our speakers pronounce the dental ejective click with such force that it has been transcribed with a velar fricative release. We refer to this phonetic variant of the ejective accompaniment as an *affricated ejective*.

## 3.4 General properties of Yeyi clicks

### 3.4.1 Places of articulation

Previous writings on Yeyi clicks are certainly right about at least one thing: there are indeed four places of articulation, which are quite easily heard to be dental, (post)alveolar, lateral, and palatal. This simple fact seems to be the one constant in the unstable domain of Yeyi click phonology; each of our 13 speakers manifests at least one click at each of these four places. This fact also distinguishes Yeyi among its fellow Bantu languages, as the sole representative that has clicks of four distinct places of articulation. Figures 1–4 show representative spectrograms (Speaker 6) of a voiced click at each of four places. It is difficult to see all of the salient acoustic features of a click in any one kind of visual representation, but we decided that spectrograms would display the major attributes in the most compact image.

It should be noted that the dental and palatal click bursts are similar in being “sloppier” and more separated from the onset of the vowel than those of the alveolar and lateral clicks. The characteristic higher frequency “snap” of the palatal click is also readily seen. Indeed, Ladefoged and Maddieson (1996) summarize the spectral characteristics of these four places across languages by saying that dental and palatal clicks have more energy above 2.5 kHz

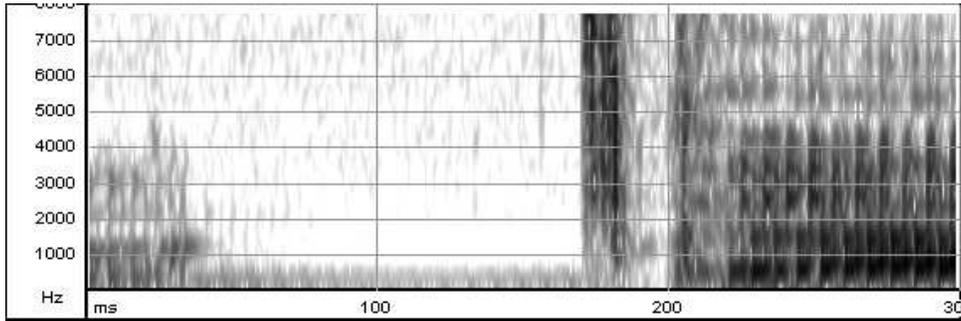


Figure 1: Voiced dental click in [ku g!awa], ‘to cut grass’

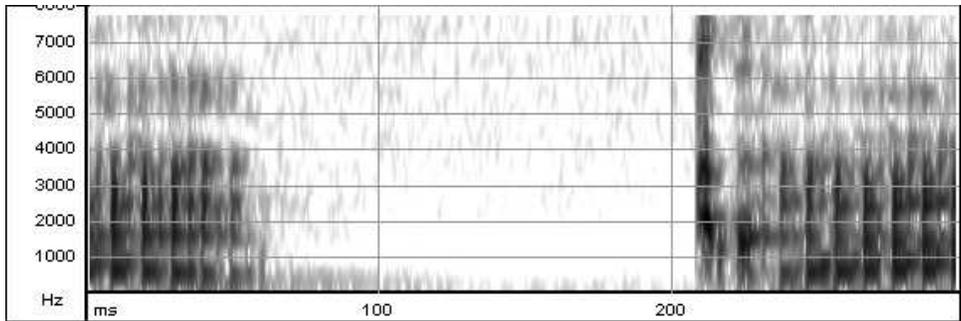


Figure 2: Voiced alveolar click in [ka g!awa], ‘calabash’

while alveolar and lateral clicks have more energy below 2.5 kHz. This statement describes the Yeyi click spectra quite well, in particular.

The similarity between the dental and palatal clicks is particularly interesting in light of the common description of the dental and *lateral* clicks together as “affricated” in the Khoisan languages (e.g. Sommer and Voßen 1992, Ladefoged and Maddieson 1996) as against the non-affricated alveolar and palatal clicks. In Yeyi, it seems that the palatal is rather more like the dental in this regard, instead of the lateral being so. The lateral instead joins the alveolar in being somewhat sharp with a short release phase, and statistical evidence of such a seemingly uncommon pattern is given later.

A small amount of palatography was conducted on Speaker 5 alone. Figures 5–7 show palatograms of dental, alveolar, and lateral clicks clipped from digital videotape of a static palatography session. The patterns of tongue contact (in black) with the palate are understandably very similar between the alveolar and lateral clicks, while the dental click contact is clearly much greater as well as being forward onto the teeth.

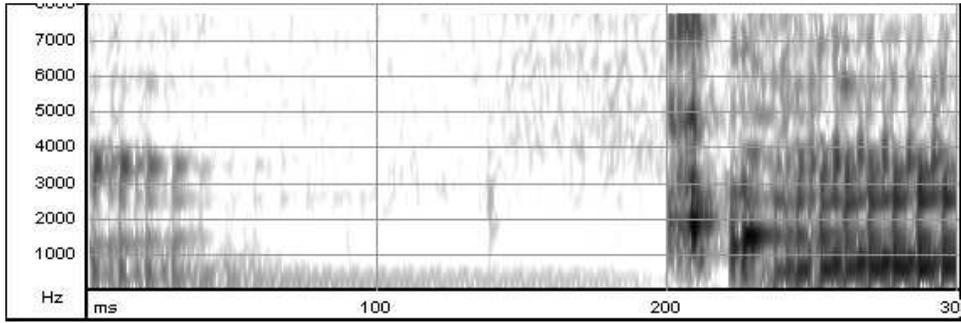


Figure 3: Voiced lateral click in [mu gllawa], 'arrow'

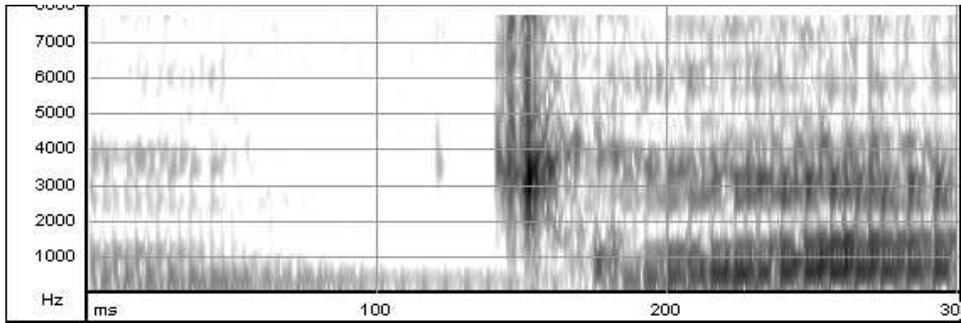


Figure 4: Voiced palatal click in [u gɟara], 'chameleon'



Figure 5: Voiced dental click in [g|awa], 'cut grass!'



Figure 6: Plain alveolar click in [ma klawá], ‘shoulders’



Figure 7: Voiced lateral click in [mu gllawa], ‘arrow’

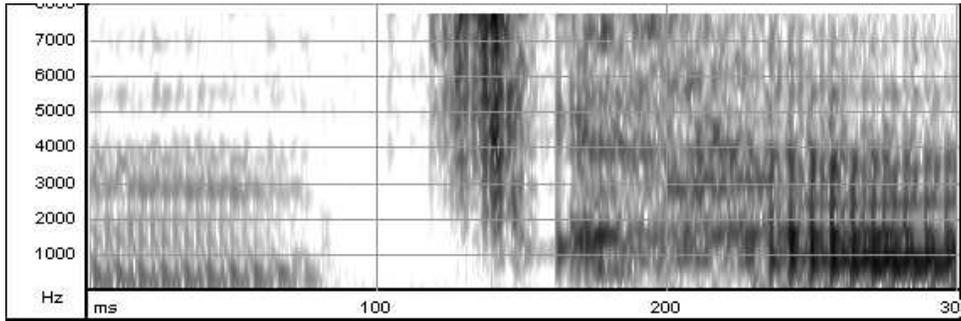


Figure 8: Aspirated dental click in [zin k<sup>h</sup>áko], ‘cheeks’

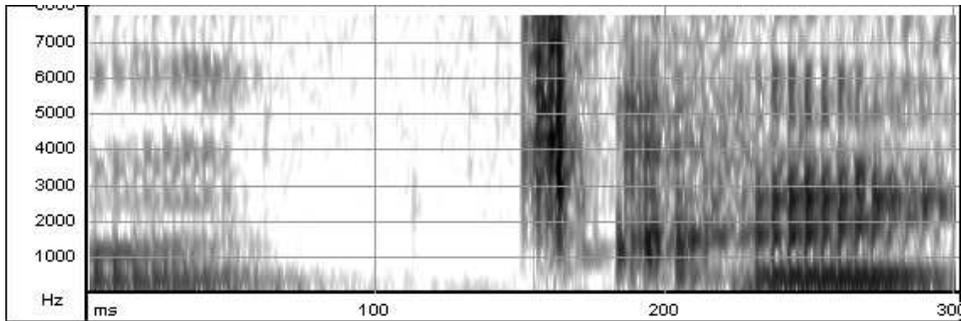


Figure 9: Affricated dental click in [wu k<sup>x</sup>íki], ‘one’

### 3.4.2 Click accompaniments

Although Sommer and Vossen (1992) identified nine click accompaniments and argued for their phonological significance, our discussion above has identified some problems with that position. We would at this time argue that there are just five accompaniments that are phonologically distinct, and a further two that can be distinguished phonetically but which are almost certainly allophones of two of the others. Spectrograms of dental clicks illustrate the seven accompaniments, again from recordings of Speaker 6 for the first six, and from Speaker 10 for the last. The important acoustic features of the accompaniments are displayed rather well this way.

Figures 8 and 9 show the aspirated click and its variant affricated form, in which louder noise can be seen during the release phase. Figures 10–13 show the plain, voiced, nasal, and glottalized dental clicks, and their defining features are visible. The expected voicing “bar” is clearly visible in Figure 11 (which is just a repeat of 1), the click in Figure 12 is obviously in the middle of a nasal, and there is marked glottalization of the vocalic segments on either side of the click in Figure 13. Finally, the ejective click and its affricated variant (found in the pronunciation of Speaker 10 for the figure) are shown in Figures 14 and 15. There is an obvious double burst here, as a result of the click being released well

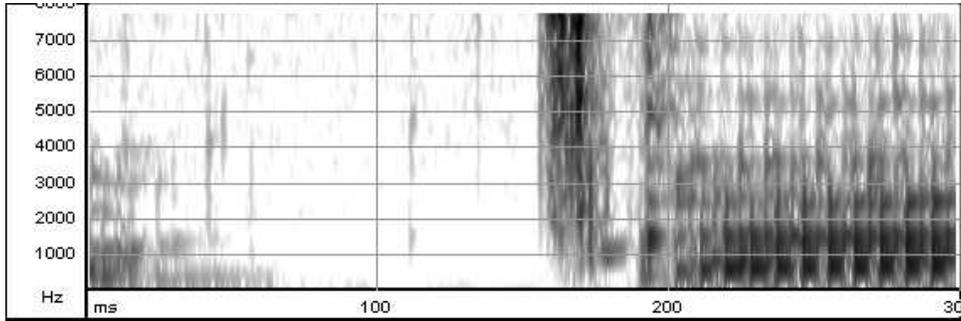


Figure 10: Plain dental click in [ku klara], ‘to cut open’

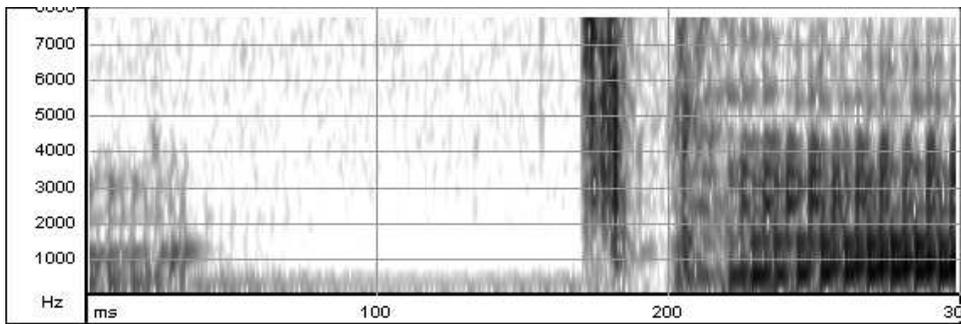


Figure 11: Voiced dental click in [ku g|awa], ‘to cut grass’

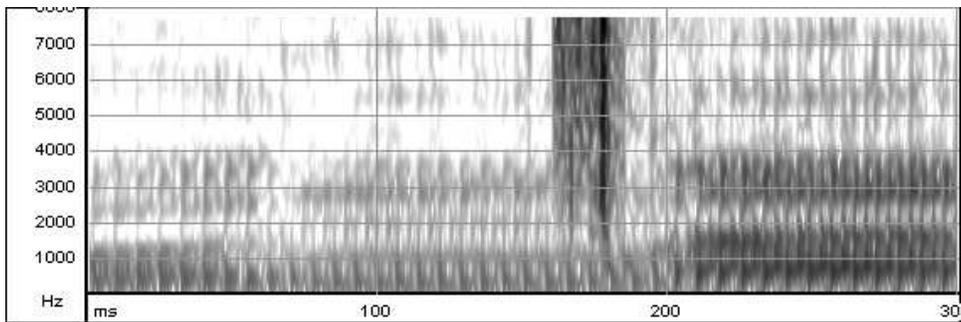


Figure 12: Nasal dental click in [ku n|amisa], ‘to give breast (suckle)’

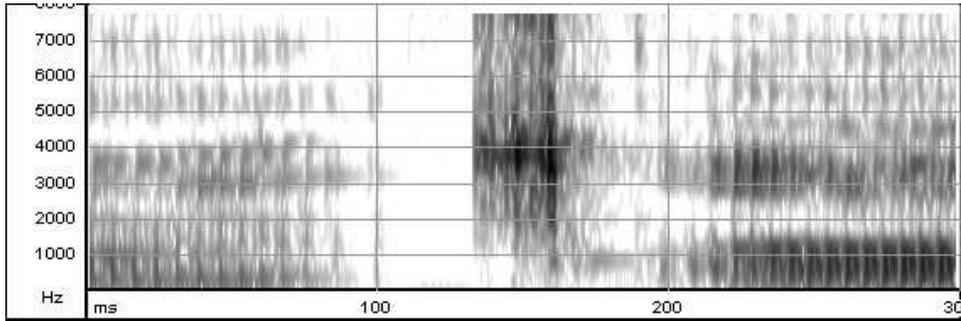


Figure 13: Glottalized dental click in [unʔ kɪ<sup>2</sup>oro], ‘a tree (*K. pinnata*)’

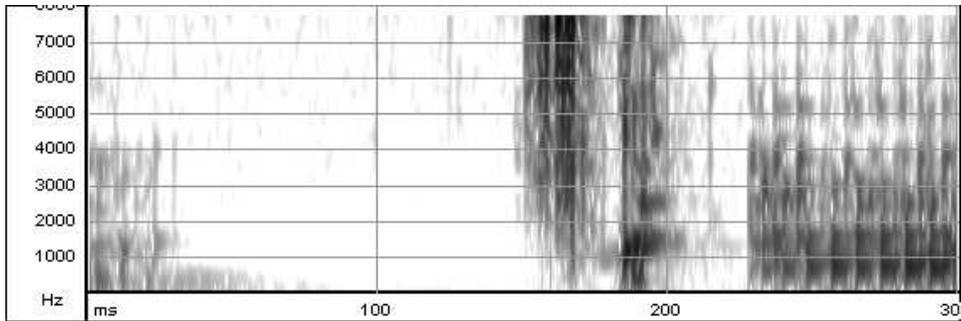


Figure 14: Ejective dental click in [ku kɪ<sup>2</sup>akasa], ‘to drizzle’

in advance of the ejective velar stop accompanying. There is no glottalization apparent in the surrounding vowels. The affricated variant in Figure 15 can be seen to exhibit a slightly louder and more drawn out velar burst at the ejective, but this is really a matter of narrow transcription rather than phonological significance. In sum, these spectrograms together with the statistical study of duration differences to follow show convincingly that the ejective and glottal stop accompaniments are very distinct in Yeyi.

## 4 Patterns of click variation

As summarized in Traill (), Köhler (1963) suggested that clicks in general tend to become non-click consonants. He also claimed that what we are calling the alveolar and palatal clicks (Ladefoged and Maddieson indicate that Köhler interchanges these terms from our usage) are more commonly involved in such changes, and further that changes affecting palatal clicks tend diachronically to precede changes of alveolar clicks. It seems that Yeyi goes against the first suggestion, in that its clicks are almost never replaced by non-click consonants. Köhler’s claim about diachronic precedence finds partial support in Yeyi, in that its alveolar clicks are very robust and are themselves used to replace the less stable lateral and palatal

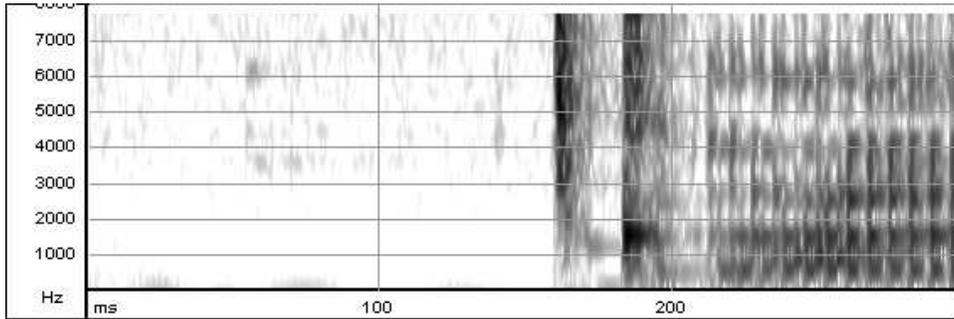


Figure 15: Affricated ejective dental click in [ku k<sup>ɛ</sup>'akasa], 'to drizzle'

clicks. Dental clicks, meanwhile, are sometimes used to replace palatal clicks, but are never substituted for lateral ones.

Lateral clicks are rather unstable, although every speaker uses one somewhere. In many cases, speakers either don't know the words that are supposed to have laterals, or they substitute alveolar clicks for the laterals. Palatal clicks are also unstable, but they seem to be somewhat more robust than the laterals. Speakers 1, 5, 6, 7, 10, and 13 all substitute either dental or alveolar clicks for some of the palatals. A given speaker may well substitute with a dental in one word but an alveolar in another.

The rare ejective clicks seem rather stable, in contrast, with just four speakers substituting for them. Speaker 5 substitutes plain clicks for the ejectives, while Speakers 7, 10, and 11 substitute glottalized clicks for the ejectives. The latter two retain the dental ejective. Although the consensus among our speakers indicates just two ejective clicks in the sample (a dental and a palatal), Speaker 12 adds an otherwise unattested alveolar ejective to the inventory in two words where others use a glottalized click. Since this speaker uses the greatest number of clicks overall, one might suggest that there was an alveolar ejective in earlier forms of Yeyi, which has now been almost completely supplanted by glottalized clicks.

## 5 Click durations as acoustic correlates

### 5.1 Duration measurements

Durations were measured using a waveform display for all types but the regular nasal clicks. Closure duration is measured as the time interval starting at the last visible glottal pulse of the open oronasal cavity, ending at the start of the click burst. Release duration is measured as the time interval starting at the beginning of the click burst, ending at the first visible and complete glottal pulse of the following vowel at the start of periodic glottal vibrations.

## 5.2 Analysis: a statistical study

Simply showing all of the different durations for the various kinds of clicks for 13 speakers would produce a further proliferation of data tables of dubious value. To extract some information from the data about interesting contrasts involving duration, we constructed two statistical “experiments” to examine the distinguishability of various sets of clicks by duration; one experiment probes the effects of closure phase duration, and the other examines release phase duration. The differences in duration that are found to be significant are controlled for experimentwise Type I error using Rom’s (1990) sequentially rejective procedure.

### 5.2.1 Experiment design

For each experiment, the duration measurements are arranged in a 2-way  $4 \times 7$  design, place  $\times$  accompaniment, with repeated measures across the 13 speakers. In order to validate a dependent group comparison, each cell in the design must be reduced to a single datum. This is achieved by using for each cell the median duration value (either closure or release, depending on which experiment) of all tokens of a particular click type for a particular speaker. All pairwise comparisons of the four places of articulation are made with two-sided Wilcoxon signed rank tests using Statview statistics software; the software provides the rank sums together with the significance levels. Because all pairwise comparisons of the seven possible accompaniments would furnish too many tests to allow good control over Type II errors under sequential rejection, a select group of comparisons were made that are deemed to be of particular interest in each experiment.

The results of the tests are reported in Tables 14 and 15, wherein the two-sided (alternative) hypothesis statements are written such that the value on the left of the  $\neq$  sign was found (by comparing the magnitudes of the positive and negative rank sums) to be **greater than** the value on the right in the cases where a clear indication of a difference was revealed by the Wilcoxon test. The null hypothesis in each case is that the two distributions are equal, and thus that the two groups cannot be distinguished by the duration.

### 5.2.2 Distinguishing accompaniments

With respect to the closure durations associated with the various click accompaniments, Table 14 shows that the plain clicks have the longest closures, while the glottalized clicks have the shortest. The plain clicks are clearly longer than the aspirated, voiced, and ejective clicks, all three of which are in turn found to have longer closures than the glottalized clicks. The voiced clicks cannot, however, be distinguished from either the aspirated or the ejective clicks by closure duration alone. The affricated clicks, which we have suggested are simply allophones of the aspirated clicks, are nonetheless found to have the longer closure durations. The resulting ordering of click accompaniments by closure duration is thus:

Table 14: Distinguishing by closure duration

Hypothesis	Significance
aspirated $\neq$ glottal	$p < 0.0001$
plain $\neq$ aspirated	$p < 0.0001$
plain $\neq$ glottal	$p < 0.0001$
voiced $\neq$ glottal	$p < 0.0001$
plain $\neq$ voiced	$p < 0.0001$
alveolar $\neq$ dental	$p < 0.0001$
palatal $\neq$ dental	$p = 0.0004$
ejective $\neq$ glottal	$p = 0.0006$
plain $\neq$ ejective	$p = 0.0011$

Accept the above hypotheses as assured to 0.01 confidence (i.e. a 1% chance or less of being mistaken).

alveolar $\neq$ lateral	$p = 0.0075$
affricated $\neq$ aspirated	$p = 0.0077$

Accept the above hypotheses as assured to 0.05 confidence (i.e. a 5% chance or less of being mistaken), and reject those below in favor of the null hypotheses.

voiced $\neq$ aspirated	$p = 0.0265$
dental $\neq$ lateral	$p = 0.1627$
alveolar $\neq$ palatal	$p = 0.4693$
lateral $\neq$ palatal	$p = 0.7173$
ejective $\neq$ voiced	$p = 0.8405$

Table 15: Distinguishing by release duration

Hypothesis	Significance
aspirated $\neq$ plain	$p < 0.0001$
aspirated $\neq$ voiced	$p < 0.0001$
glottal $\neq$ plain	$p < 0.0001$
glottal $\neq$ voiced	$p < 0.0001$
dental $\neq$ alveolar	$p < 0.0001$
palatal $\neq$ alveolar	$p < 0.0001$
ejective $\neq$ voiced	$p = 0.0004$

Accept the above hypotheses as assured to 0.01 confidence.

dental $\neq$ lateral	$p = 0.0011$
palatal $\neq$ lateral	$p = 0.0013$
ejective $\neq$ plain	$p = 0.0019$

Accept the above hypotheses as assured to 0.05 confidence, and reject those below in favor of the null hypotheses.

aspirated $\neq$ ejective	$p = 0.0395$
aspirated $\neq$ glottal	$p = 0.0553$
plain $\neq$ voiced	$p = 0.0812$
dental $\neq$ palatal	$p = 0.1119$
ejective $\neq$ glottal	$p = 0.4209$
aspirated $\neq$ affricated	$p = 0.5147$
alveolar $\neq$ lateral	$p = 0.9653$

plain > affric. > (asp., voiced, eject.) > glott.

The affricated ejectives were not included in the statistical study because of the small number of tokens in which they were noted.

The above result shows an interesting point: the plain clicks display the longer closure phase that has been said to be characteristic of *fortis* stops (cf. Kohler 1984, Fulop and Dobrovolsky 1999), where this manner term is used to describe a series of stops showing greater articulatory and perhaps glottal tension than others in the same language. Fortis stops in other languages are often also plain (i.e. having small positive voice onset time). We cannot say at this point whether other correlates of stop tension could be manifested in the plain clicks of Yeyi.

Another point to mention is that the significant difference in closure duration between the ejective and glottalized clicks provides further evidence to convince us that they really are two distinct accompaniments, as the earlier spectrograms (and our ears) led us to believe.

The second experiment shows that the various click accompaniments are not distinguished well by release duration. Table 15 shows that along this measure, the aspirated, affricated, glottalized, and ejective clicks form a group which is clearly longer in the release phase than the opposing pair of the plain and voiced clicks. The four members of the first group cannot be distinguished from each other this way however, and neither can the two members of the opposing group. This result simply confirms the intuitive notion that clicks with accompaniments which inherently take more time to produce have longer release phases.

### 5.2.3 Distinguishing places

Turning back to the first experiment, alveolar and palatal clicks are each seen to have longer closures than dentals, and the alveolars are also longer than the laterals. The dentals and laterals cannot be distinguished in this way, and neither can the palatals be distinguished from either the alveolars or the laterals. The alveolar and palatal clicks thus seem to form a group with longer closure durations than the other group containing the laterals and dentals, but this ordering of the two pairs can only be supposed indirectly because the palatals and laterals cannot be directly distinguished from each other in this way.

Both dental and palatal clicks are seen to have longer release phases than the alveolar and also the lateral clicks. There is thus a simple ordering of places according to release duration:

(dental, palatal) > (alveolar, lateral)

In both pairs, however, the two members are indistinguishable from each other this way. This ordering accords with the impressions imparted by the spectrograms presented earlier in which the dentals and palatals seemed to be the more affricated. We have thus provided the promised statistical evidence for the apparently uncommon similarity of dental and palatal clicks along this parameter.

A more intriguing result, however, is that all four places of articulation are interdistinguishable by duration so long as both closure and release duration are considered. That is, each possible pair of click places is found to be distinct by *either* closure duration *or* release duration. The alveolars are distinguished from the dentals along both of these measures, with the former having the longer closure phase and the latter having the longer release.

## 6 Summary and conclusions

This paper has presented a description of click sounds as they are now found in Yeyi. From recordings of 47 words containing clicks as spoken by 13 speakers in the field, we have conducted both a general description of the sounds as well as a statistical study of the operation of duration as an acoustic correlate.

Yeyi was confirmed to have four places of articulation for clicks, namely dental, alveolar, palatal, and lateral. These four click classes were found to display spectral features more or less in accord with accounts of click sounds in general, except for the seemingly unusual similarity of the dental and palatal clicks as somewhat affricated, while the alveolar and lateral clicks were found to be rather sharply released in contrast. This pattern was confirmed by the statistical study of release phase durations; the study also found the unexpected fact that the four places of articulation are completely interdistinguishable by a combination of closure and release phase duration measures. This shows that click duration acts statistically in Yeyi as a robust correlate of place; the perceptual and linguistic import of this is as yet unknown.

Our analysis of many speakers permitted us to survey the patterns of sound change which clicks are undergoing as Yeyi becomes moribund. It was found that clicks are almost never replaced by non-click consonants, in contrast to generalizations reported by Köhler (1963). We also observed that the alveolar clicks seem to be the most robust; rather than being replaced, they are most often used to replace other less stable clicks, such as the lateral and palatal.

Our examination of the recordings concluded that there are five phonologically distinct click accompaniments, namely plain (voiceless unaspirated), voiced, nasal, glottalized (i.e. contained within a glottal stop), and ejective. The latter are quite rare, occurring regularly across speakers in just two words in the corpus, but are nonetheless easily shown by both spectrography and duration statistics to be a distinct accompaniment in Yeyi. The statistical analysis of duration measurements also showed the plain clicks to have the longest closure durations. This fact accords with cross-linguistic findings for plain fortis stops other than clicks, and so these clicks further illustrate a commonly attested correlation between stop length and small VOT that quantifies the meaning of the term *fortis* in modern phonetics.

The variation of the use of click sounds across speakers is quite striking in our data, and serves to show the importance of recording as many speakers as possible in a phonetic study

of a dying language, particularly one which focuses on rare sounds. We hope that this study can serve as a definitive description of the current state of Yeyi clicks, a state which still stands at the apex of click diversity in the Bantu language family.

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## Transcriptions of the words containing noncontinuant clicks

Table 16: Transcriptions, set 1

Gloss	Sp. 1c	Sp. 2c	Sp. 3c
shelters			
cheeks		[zɪn k <sup>h</sup> ako]	
to cut open	[ku k ara]	[ku k ara]	[ku k ara]
to cut grass			[ku g awa]
hunting spider			
to build	[kui g mi]		[kui g mi]
Kigelia pinnata (a tree)		[unʔ k <sup>ʔ</sup> oro]	[unʔ k <sup>ʔ</sup> oro]
one	[wu k <sup>x</sup> iki]	[wu k <sup>x</sup> iki]	[u k <sup>x</sup> iki]
to drizzle	[ku k <sup>ʼ</sup> akasa]	[ku k <sup>ʼ</sup> akasa]	[ku k <sup>ʼ</sup> akasa]
sunset	[shɪ kunʔk <sup>ʼ</sup> umu]	[shɪ kunʔk <sup>ʼ</sup> umu]	[shɪ kunʔk <sup>ʼ</sup> umu]
hiccough	[kaŋʔ k <sup>ʼ</sup> uri]	[ʔaʔ k <sup>ʼ</sup> uri]	[kaŋ k <sup>ʼ</sup> uri]
tobacco (pipe)		[ŋ g øwe]	[u ŋ øwi] (1st) [u ŋg øwi] (2nd, 3rd)
small	[wunʔ k <sup>ʼ</sup> ene]	[wunʔ k <sup>ʼ</sup> ene]	[ũʔ k <sup>ʼ</sup> ene]
nothing	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]	[wu k <sup>h</sup> u]
dumb	[ku k <sup>h</sup> uru]		[u k <sup>h</sup> uru]
to taste	[kura k <sup>ʼ</sup> awa]	[kura k <sup>ʼ</sup> awa]	[kura k <sup>ʼ</sup> awa]
shoulders	[ma k <sup>ʼ</sup> awa]	[ma k <sup>ʼ</sup> awa]	
owls	[m̥bã k <sup>ʼ</sup> u]	[m̥ba k <sup>ʼ</sup> u]	[m̥bã k <sup>ʼ</sup> ũ]
rainbows		[imba k <sup>ʼ</sup> utama tjembwa]	[m̥ba k <sup>ʼ</sup> utamaka]
poor		[wu k <sup>ʼ</sup> ani]	
to be beautiful	[ku k <sup>ʼ</sup> apa]	[ku k <sup>ʼ</sup> apa]	[kura k <sup>ʼ</sup> apa]
owl	[u k <sup>ʼ</sup> u]	[u k <sup>ʼ</sup> u]	[u k <sup>ʼ</sup> u]
whirlwind	[u k <sup>ʼ</sup> uri]	[u k <sup>ʼ</sup> uri]	[u k <sup>ʼ</sup> uri]
rainbow		[u k <sup>ʼ</sup> utama tjembwa]	[u k <sup>ʼ</sup> utamaka]
correct	[u k <sup>ʼ</sup> a]	[u k <sup>ʼ</sup> ah]	
to sprout	[ku g <sup>ʼ</sup> utura]		[ku g <sup>ʼ</sup> utura]
calabash	[ka g <sup>ʼ</sup> awa]	[ka g <sup>ʼ</sup> awa]	[shɪ g <sup>ʼ</sup> awa]
cricket	[ha g <sup>ʼ</sup> uru]		
bat-eared fox		[unʔ k <sup>ʼ</sup> osire]	[ũʔ k <sup>ʼ</sup> osire]
wrist, ankle	[kãʔ k <sup>ʼ</sup> ami]	[kaŋʔ k <sup>ʼ</sup> ami]	[kaŋʔ k <sup>ʼ</sup> ami]
cooking pots	[tũʔ k <sup>ʼ</sup> uma]	[tũʔ k <sup>ʼ</sup> uma]	[tuŋʔ k <sup>ʼ</sup> uma]

tsaro fruit	[mũʔ k!ʔuni]	[unʔ k!ʔuni]	[muŋʔ k!ʔuni]
to knock	[kũʔ k!ʔũʔk!ʔũna]		[kũʔ k!ʔũʔk!ʔũna]
to chop	[kunʔ k!ʔatara]	[ŋʔ k!ʔatara]	[kũʔ k!ʔatara]
cooking pot	[kãʔ k!ʔuma]	[kaŋʔ k!ʔuma]	[kaŋʔ k!ʔuma]
to keep sticks in the fire		[kura k!ʰok!ʰo]	[kui k!ʰok!ʰo]
dusk (sg.)		[ma g  ani]	
arrow	[mu g  awa]	[mu g  awa]	[mu g!awa]
woman	[mu g  ekwa]	[mu g  ekwa]	[mu g  ekwa]
dusk (pl.)			
to slap	[kui kʔʰo̱a]	[kuræ kʔʰo̱a]	[kui kʔʰo̱a]
scarification	[shi kʔa]		[shi kʔa]
weak	[u kʔʰamukʔʰamu]	[u kʔʰamukʔʰamu]	[u kʔʰamukʔʰamu]
chameleon	[u gʔo̱ara]	[u gʔo̱ara]	[u gʔo̱ara]
sunrise	[ma kwẽkʔʰumu]	[ma kʰweŋʔkʔʰumu]	[ma kʰweŋʔkʔʰumu]
to smash up	[ku kʔʰapara]	[ku kʔʰapara]	[ku kʔʰapura]
narrow passage	[ku k!o] (1st) [wu k!o] (2nd)	[kunʔ kʔʰo]	[ŋʔ kʔʰo]

Table 17: Transcriptions, set 2

Gloss	Sp. 4c	Sp. 5c	Sp. 6c
shelters	[ma k <sup>h</sup> ako]		[zin k <sup>h</sup> ako]
cheeks			[zin k <sup>h</sup> áko]
to cut open	[ku k ara]		[ku k ara]
to cut grass	[ku g awa]	[ku g awa]	[ku g awa]
hunting spider			[namu g upasi]
to build	[kui g mi]		[kui g mi]
Kigelia pinnata (a tree)		[un? k <sup>l</sup> ?oro]	[un? k <sup>l</sup> ?oro]
one	[wu k <sup>x</sup> igi]	[wu k <sup>x</sup> iki]	[wu k <sup>x</sup> iki]
to drizzle	[ku k <sup>l</sup> 'akasa]	[ku k ak asa]	[ku k <sup>l</sup> 'akasa]
sunset	[shɪ kun?k <sup>l</sup> ?umu]	[shɪ kuŋk <sup>l</sup> ?umu]	[shɪ kuŋ?k <sup>l</sup> ?umu]
hiccough	[ka? k <sup>l</sup> ?uri]	[kaŋ? k <sup>l</sup> ?uri]	[kaŋ? k <sup>l</sup> ?uri]
tobacco (pipe)	[iŋ g øwe]	[iŋ g owe]	[iŋ g owe]
small	[wun? k <sup>l</sup> ?ene]	[wuŋ? k <sup>l</sup> ?ene]	[ŋ? k <sup>l</sup> ?ene]
nothing	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]
dumb		[mu k <sup>h</sup> uru]	[u k <sup>h</sup> uru]
to taste	[kura k!awa]	[kura k!awa]	[kura k!awa]
shoulders	[ma k!awa]	[ma k!awa]	[ma k!awa]
owls	[m̄ba k!u]	[m̄bã? k <sup>l</sup> ?ũ]	[m̄ba k!u]
rainbows	[m̄a k <sup>h</sup> utama]	[waŋ g!utama tembwa]	[m̄ba k!utama]
poor	[wu k!ani]		
to be beautiful	[ku k!apa]	[ku k!apa]	[ku k!apa]
owl	[wu k!u]	[u g!u]	[wu k!u]
whirlwind	[u k!uri]		[u k!uri]
rainbow	[u k <sup>h</sup> utama]	[u g!utama t̄mbwa]	[u k!utama]
correct	[u k!a]		[wu k!a]
to sprout	[ku g!utura]	[ku g!utura]	[ku g!utura]
calabash	[ka g!awa]	[ka g!awa]	[ka g!awa]
cricket	[ha g!uru]		
bat-eared fox	[ũ? k <sup>l</sup> ?osire]	[un? k <sup>l</sup> ?osire]	[un? k <sup>l</sup> ?osire]
wrist, ankle	[kã? k <sup>l</sup> ?ami]	[kaŋ? k <sup>l</sup> ?ami]	[kaŋ? k <sup>l</sup> ?ami]
cooking pots	[tiŋ? k <sup>l</sup> ?uma]	[tũ? k <sup>l</sup> ?uma]	[tũ? k <sup>l</sup> ?uma]
tsaro fruit	[mũ? k <sup>l</sup> ?uni]	[mũ? k <sup>l</sup> ?uni]	[mũ? k <sup>l</sup> ?uni]
to knock	[kũ? k <sup>l</sup> ?ũ?k <sup>l</sup> ?ũna]	[ku? k <sup>l</sup> ?u?k <sup>l</sup> ?u:na]	[kũ k <sup>l</sup> ?ũ?k <sup>l</sup> ?una]
to chop	[kũ? k <sup>l</sup> ?atara]	[kũ? k <sup>l</sup> ?atara]	[kũ? k <sup>l</sup> ?atara]
cooking pot	[kãŋ? k <sup>l</sup> ?uma]	[kã? k <sup>l</sup> ?uma]	[kaŋ? k <sup>l</sup> ?uma]
to keep sticks in the fire	[kura k <sup>h</sup> oko]	[kui k <sup>h</sup> okok <sup>h</sup> oko]	[kura k <sup>l</sup> okok <sup>h</sup> oko]

dusk (sg.)		[ru g  ani]	[ru g  ani]
arrow	[ka g  awa]	[mu g  awa]	[mu g  awa]
woman	[mu g ekwa]	[mu g ek <sup>^</sup> a]	[mu g ek <sup>h</sup> wa]
dusk (pl.)		[ma g  ani]	[ma g  ani]
to slap	[kura k <sup>h</sup> o <sub>o</sub> a]	[kui k <sup>h</sup> o <sub>o</sub> a]	[kui k <sup>h</sup> o <sub>o</sub> a]
scarification	[shi k#a]		[shi k!a]
weak	[u k <sup>h</sup> amuk <sup>h</sup> amu]	[ku k amuk amu]	[u k <sup>h</sup> amuk <sup>h</sup> amu]
chameleon	[u g <sup>o</sup> ara]	[u g o <sub>o</sub> ara]	[u g <sup>o</sup> ara]
sunrise	[ma k <sup>^</sup> ej?k <sup>?</sup> umu]	[ma k <sup>h</sup> wej?k  <sup>?</sup> umu]	[ma k <sup>h</sup> wej?k  <sup>?</sup> umu]
to smash up	[ku k <sup>h</sup> 'apura]	[ku k!apara]	[ku k <sup>h</sup> 'apara]
narrow passage	[kuraŋ k <sup>?</sup> o]		[uŋ? k <sup>?</sup> o]

Table 18: Transcriptions, set 3

Gloss	Sp. 7c	Sp. 8c	Sp. 9c
shelters	[zin k <sup>h</sup> àko]	[zin k <sup>h</sup> áko]	[zin k <sup>h</sup> ako]
cheeks	[zin k <sup>h</sup> áko]	[zin k <sup>h</sup> àko]	[zin k <sup>h</sup> ako]
to cut open	[ku k ara]	[ku k ara]	[ku k ara]
to cut grass	[ku g awa]	[ku g awa]	[ku g awa]
hunting spider	[namu g upasi]	[namu g upasi]	[namu g upasi]
to build	[kui g ini]	[kui g imi]	[kui g imi]
Kigelia pinnata (a tree)	[mũ? k <sup>l</sup> oro]	[un? k <sup>l</sup> oro]	[un k <sup>l</sup> oro]
one	[wu k <sup>h</sup> iki]	[wu k <sup>x</sup> iki]	[wu k <sup>x</sup> iki]
to drizzle	[kũ? k <sup>l</sup> akasa]	[ku? k <sup>x</sup> akasa]	[ku k <sup>x</sup> akasa]
sunset	[shi kuŋ?k <sup>l</sup> umu]	[shi kun?k <sup>l</sup> umu]	[shi kũ? ŋ <sup>l</sup> umu]
hiccough	[kaŋ? k <sup>l</sup> uri]	[ka? k <sup>l</sup> uri]	[ka? k <sup>l</sup> uri]
tobacco	[ŋ g øwe]	[ŋ g øwe]	[ŋ g øwe]
small	[wuŋ? k <sup>l</sup> ene]	[wuŋ? k <sup>l</sup> ene]	[wũ? k <sup>l</sup> ene]
nothing	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]
dumb	[ku k <sup>h</sup> uru]	[u k <sup>h</sup> uru]	[wu k <sup>h</sup> uru]
to taste	[kura k!awa]	[kura k!awa]	[kura k!awa]
shoulders	[ma k!awa]	[ma k!awa]	[ma k!awa]
owls	[m̄ba k!u]	[m̄ba k!u]	[m̄ba k!u]
rainbows	[m̄ba g!utama]	[m̄ba k!utama]	[m̄ba k!utama]
to be beautiful	[ku k!apa]	[ku k!apa]	[ku k!apa]
owl	[u k!u]	[u k!u]	[u k!u]
whirlwind	[u k!uri]	[u k!uri]	[u k!uri]
rainbow	[ŋ k!utama]	[u k!utama]	[u k!utama]
correct	[ku k!a]	[ku k!a]	[wu k!a]
to sprout	[ku g!utura]	[ku g!utura]	[ku g!utura]
calabash	[ka g!awa]	[ka g!awa]	[ka g!awa]
bat-eared fox	[ũ? k <sup>l</sup> osire]	[un k <sup>l</sup> osire]	[ũ k <sup>l</sup> osire]
wrist, ankle	[kã? k <sup>l</sup> ami]	[kã k <sup>l</sup> ami]	[kã k <sup>l</sup> ami]
cooking pots	[tũ? k <sup>l</sup> uma]	[ti? k <sup>l</sup> uma]	[tũ? k <sup>l</sup> uma]
tsaro fruit	[mũ? k <sup>l</sup> uni]	[mũ? k <sup>l</sup> uni]	[mũ? k <sup>l</sup> uni]
to knock	[kũ? k <sup>l</sup> ũ?k <sup>l</sup> una]	[kũ? k <sup>l</sup> ũ?k <sup>l</sup> una]	[kũ? k <sup>l</sup> ũ?k <sup>l</sup> una]
to chop	[kũ? k <sup>l</sup> atara]	[ku? k <sup>l</sup> atara]	[kun? k <sup>l</sup> atara]
cooking pot	[kã? k <sup>l</sup> uma]	[kaŋ? k <sup>l</sup> uma]	[ka? k <sup>l</sup> uma]
to keep sticks in the fire	[kura k <sup>h</sup> okok! <sup>h</sup> oko]	[kura k <sup>h</sup> okok! <sup>h</sup> oko]	[kura k <sup>h</sup> okok! <sup>h</sup> oko]
dusk (sg.)	[ru g!ani]	[ru g!ani]	[ru g!ani]
arrow	[mu g!awa]	[mu g!awa]	[mu g awa]

woman	[mu g!ek <sup>h</sup> a]	[mu g  ekwa]	[mu g  ekwa]
dusk (pl.)	[ma g!ani]	[ma g!ani]	[ma g!ani]
to slap	[kui k  <sup>h</sup> a]	[kui k# <sup>h</sup> o <sub>a</sub> ]	[kui k# <sup>h</sup> o <sub>a</sub> ]
scarification	[shi k a]	[shi k#a]	[shi k#a]
weak	[ku k <sup>h</sup> amuk <sup>h</sup> am]	[ku k#amuk#amu]	[u k# <sup>h</sup> amuk# <sup>h</sup> amu]
chameleon	[u g#o <sub>ara</sub> ]	[u g#o <sub>ara</sub> ]	[u g#o <sub>ara</sub> ]
sunrise	[ma k <sup>h</sup> weŋʔk  <sup>ʔ</sup> umu]	[ma k <sup>h</sup> weŋk# <sup>ʔ</sup> umu]	[ma k <sup>h</sup> weŋk# <sup>ʔ</sup> umu]
to smash up	[kũ k'apara] (1st) [kũʔ k  <sup>ʔ</sup> apara] (2nd)	[ku k#'apara]	[ku k#'apara]
narrow passage	[kuŋ k  <sup>ʔ</sup> o]	[kuŋ k# <sup>ʔ</sup> o]	[wuŋ k# <sup>ʔ</sup> o]

Table 19: Transcriptions, set 4

Gloss	Sp. 10c	Sp. 11c	Sp. 12c	Sp. 13c
shelters	[zin k <sup>h</sup> ako]	[zin k <sup>h</sup> ako]	[zin k <sup>h</sup> ako]	[ɲ k <sup>h</sup> ako]
cheeks				
to cut open	[ku k ara]	[ku k ara]	[ku k ara]	[ku k ara]
to cut grass	[ku g awa]	[ku g awa]	[ku g awa]	[ku g awa]
hunting spider	[nama g upaka]	[nama g upaka]	[namu g upaka] (1st) [ku g upaka] (2nd)	[namu g upaka]
to build		[kui g ɪni]	[kui g ɪni]	[kui g ɪni]
Kigelia pinnata (a tree)	[ɲʔ k  <sup>2</sup> oro]	[unʔ k  <sup>2</sup> oro]	[unʔ k  <sup>2</sup> oro]	[ɲʔ k  <sup>2</sup> oro]
one	[wu k <sup>ɪ</sup> iki]	[wu k <sup>ɪ</sup> iki]	[wu k <sup>ɪ</sup> iki]	[wu k <sup>ɪ</sup> iki]
to drizzle	[ku k  <sup>ɪ</sup> akasa]	[uʔ k  <sup>ɪ</sup> akasa]	[ku k  <sup>ɪ</sup> akasa]	[ku k  <sup>ɪ</sup> akasa]
sunset	[shi kunʔ k  <sup>ɪ</sup> umu]	[shi kũʔ k  <sup>ɪ</sup> umu]	[shi kunʔ k  <sup>ɪ</sup> umu]	[shi kunʔ k  <sup>ɪ</sup> umu]
hiccough	[kãʔ k  <sup>ɪ</sup> uri]	[kaʔ k  <sup>ɪ</sup> uri]	[ka k  <sup>ɪ</sup> uri]	[kaʔ k  <sup>ɪ</sup> uri]
tobacco	[ɲ g owe]	[ɲ g owe]	[ɲ g owe]	[ɲ g owe]
small	[uɲʔ k  <sup>ɪ</sup> ene]	[ɲʔ k  <sup>ɪ</sup> ene]	[wun k  <sup>ɪ</sup> ene]	[uɲʔ k  <sup>ɪ</sup> ene]
nothing	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]	[ku k <sup>h</sup> u]
dumb	[ku k <sup>h</sup> uru]	[u k <sup>h</sup> uru]	[wu k <sup>h</sup> uru]	[u k <sup>h</sup> uru]
to taste	[kura k awa]	[kura k awa]	[kura k awa]	[kura k awa]
shoulders	[ma k awa]	[ma k awa]	[ma g awa]	[ma k awa]
owls	[ɱba k u]	[ɱba k u]	[ɱba k u]	[ɱba k u]
rainbows	[ɱbaɲ k utama]	[ɱba k utama]	[ma k utama]	[ɱba k utama]
to be beautiful	[ku k apa] (1st) [ku k epa] (2nd)	[ku k apa]	[ku k apa] (1st) [ku k apana] (2nd)	[ku k apa]
owl	[wu k u]	[u k u]	[u k u]	[u k u]
whirlwind	[u k uri]	[u k uri]	[u k uri]	[u k uri]
rainbow	[ɲ k utama]	[u k utama]	[u k utama]	[u k utama]
correct	[wu k a]	[wu k a]	[wu k a] (1st) [g k a] (2nd)	[u k a]
to sprout	[ku g utura]	[ku g utura]	[ku g utura]	[ku g utura] (1st) [ɲ g utura] (2nd)
calabash	[ka g awa]	[ka g awa]	[ka g awa]	[ka g awa]
bat-eared fox	[unʔ k  <sup>ɪ</sup> osire]	[ɲ k  <sup>ɪ</sup> osire]	[ɲ k  <sup>ɪ</sup> osire]	[ɲʔ k  <sup>ɪ</sup> osire]
wrist, ankle	[kaɲ k  <sup>ɪ</sup> ami]	[ka k  <sup>ɪ</sup> ami]	[ka k  <sup>ɪ</sup> ami]	[ka k  <sup>ɪ</sup> ami]
cooking pots	[tuɲʔ k  <sup>ɪ</sup> uma]	[tũʔ k  <sup>ɪ</sup> uma]	[tunʔ k  <sup>ɪ</sup> uma]	[tuɲʔ k  <sup>ɪ</sup> uma]
tsaro fruit	[mũʔ k  <sup>ɪ</sup> uni]	[unʔ k  <sup>ɪ</sup> uni]	[unʔ k uni]	[muɲʔ k  <sup>ɪ</sup> uni]
to knock	[kũʔ k  <sup>ɪ</sup> ũʔ k  <sup>ɪ</sup> una]	[kũʔ k  <sup>ɪ</sup> ũʔ k  <sup>ɪ</sup> una]	[kũʔ k  <sup>ɪ</sup> ũʔ k  <sup>ɪ</sup> una]	[kũʔ ɲ ũɲ una]
to chop	[kũʔ k  <sup>ɪ</sup> atara]	[kũʔ k  <sup>ɪ</sup> atara]	[kunʔ k  <sup>ɪ</sup> atara]	[ɲʔ k  <sup>ɪ</sup> atara]
cooking pot	[kaɲʔ k  <sup>ɪ</sup> uma]	[kaɲʔ k uma]	[kaʔ k  <sup>ɪ</sup> uma]	[kaɲʔ k  <sup>ɪ</sup> uma]
to keep sticks in the fire	[kura k  <sup>h</sup> okok  <sup>h</sup> oko]	[kura k okok oko]	[kura k  <sup>h</sup> okok  <sup>h</sup> oko]	[kura k okok oko]
dusk (sg.)	[ru g ani]	[ru g ani]	[ma g ani]	[ru g ani]
arrow	[mu g awa]	[mu g awa]	[mu g awa]	[mu g awa]
woman	[mu g ekwa]	[mu g ekwa]	[mu g ekwa]	[mu g ekwa]
dusk (pl.)	[ma g ani]	[ma g ani]	[ma g ani]	[ma g ani]
to slap	[kui k <sup>+</sup> o <sup>a</sup> ]	[kui k <sup>+</sup> o <sup>a</sup> ]	[kui k <sup>+</sup> o <sup>a</sup> ]	[kui k <sup>+</sup> o <sup>a</sup> ]
scarification	[shi k a]	[shi k <sup>+</sup> a]	[shi k <sup>+</sup> a]	[shi k a]
weak	[ku k <sup>+</sup> amuk <sup>+</sup> amu]	[kui k <sup>+</sup> amuk <sup>+</sup> amu]	[u k <sup>+</sup> amuk <sup>+</sup> amu]	[u k <sup>+</sup> amuk <sup>+</sup> amu]
chameleon	[u g <sup>+</sup> qara]	[u g <sup>+</sup> qara]	[u g <sup>+</sup> qara]	[u g <sup>+</sup> qara]
sunrise	[ma k <sup>h</sup> weɲk  <sup>ɪ</sup> umu]	[ma k <sup>h</sup> weʔk <sup>+</sup> umu]	[ma kweɲk <sup>+</sup> umu]	[ma kweɲk <sup>+</sup> umu]
to smash up	[ku k <sup>+</sup> apara]	[kuʔ k <sup>+</sup> apara]	[ku k <sup>+</sup> apara]	[ku k <sup>+</sup> apara]
narrow passage	[ũʔ k <sup>+</sup> o]	[unʔ k <sup>+</sup> o]	[wuɲʔ k <sup>+</sup> o]	[un k <sup>+</sup> o]