Banyaduq Prestopped Nasals: Synchrony and Diachrony[1]

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1 Introduction

This paper provides an introduction to Banyaduq, a Land Dayak language spoken in West Kalimantan Province, Indonesia, which has never been described previously in the literature. The Land Dayak languages of Borneo are known in the phonological literature for the occurrence of word-final 'preploded' or 'prestopped' nasals, homorganic sequences of an oral followed by a nasal closure. Prestopped nasals in these languages have generally been analyzed in the literature as 'complex' allophones of 'plain' nasals, occurring word-finally after oral vowels (e.g., Scott 1964, Court 1970, Anderson 1976, Boutin and Howery 1991, Yanti 2010). We give evidence from the dialect of Banyaduq spoken in the village of Sangke, in which, as will be seen, prestopped nasals have become phonemic, showing that the allophonic analysis is not correct for all languages displaying prestopped nasals. We draw a direct connection between the phonemic status of these prestopped nasals and a diachronic process in which prestopped nasals become oral stops. Our data are taken from three varieties of Banyaduq, with special emphasis on Sangke Banyaduq, the native language of one of the authors of this article (Kristian).

The following are examples of prestopped nasals in monomorphemic Sangke Banyaduq words, contrasted with word-final oral stops and plain nasals. As Banyaduq has no commonly used orthography, and as allophonic nasalized vowels are relevant to prestopping (cf. section 2.5), we list our forms in broad phonetic transcription with vowel nasalization marked. To emphasize this, we enclose transcriptions of our data in brackets.

(1)	Labial	Alveolar	Velar
Stop	a. [adup] 'self'	e. [sampat] 'available'	i. [ansak] 'red'
Plain nasal	b. [akum] 'you (pl)	f. [umãn] 'eat'	j. [sosoŋ] 'breast'
Prestopped nasal	c. [asupm] 'mango'	g. [ikatn] 'fish'	k.[turakŋ] 'bone'
	d. [mõrupm] 'to fly'	h. [mãtatn] 'throw away'	l. [barekŋ] 'hand'

Researchers variously transcribe the surface phonetic form of prestopped nasals as single, complex segments (e.g., [^{t}n]) or as sequences of segments ([tn]). We are not concerned with what phonetic differences this would imply, and simply transcribe the surface forms from our own data as sequences ([tn]). We stress that this is not meant to take a theoretical stand on whether or not they are *underlyingly* sequences of two units (/tn/) or complex (or 'contour') segments (/^{t}n/). Although this is an interesting question, as we shall discuss later, there is currently little evidence to choose between the two. When citing data from other authors, we will preserve their transcription choices.

As just mentioned, prestopped nasals are commonly analyzed as allophones of plain nasals. Following such an analysis, (1c) [ikatn] 'fish' would be derived from /ikan/, with the surface [tn] deriving from a 'prestopping' rule targeting a final /n/ following an oral vowel.

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However, as we shall show below, the distribution of prestopped nasals is not completely predictable in Banyaduq. Not only are there Banyaduq forms with surface plain nasals following an oral vowel, but there are also those with prestopped nasals following nasalized vowels. Thus, as we will see in more detail later, the oral stop portion of prestopped nasals must be present in some fashion in the underlying representation. We attribute this to a breakdown of the prestopping process mentioned above, due to a combination of specific diachronic changes and, perhaps, to language contact.

A second, related point of interest in Banyaduq is the optional process, seen especially in younger speakers of Sangke Banyaduq, in which the nasal portion of prestopped nasals is deleted—e.g., [ikat] is in free variation with [ikatn]. This suggests that the synchronic situation we posit for Banyaduq prestopped nasals puts Banyaduq at an intermediate stage of an areal diachronic process in which final nasals become oral stops following an oral vowel (Blust 1997):

(2)	*ŋ#	*tuleqaŋ ‘bone’	(proto-Malayo-Polynesian, Blust 1997)
	kŋ#~k#	turakŋ~turak id.	(Banyaduq, (=1k))
	k#	tulak id.	(Urak-Lawoi, Blust 1997)

This makes Banyaduq of further interest because it provides—as far as we are aware—previously undocumented detail of specifically how this sound change can develop. We propose that this is directly connected to the phonemic status of prestopped nasals—the loss of the nasal consonant simplifies a *phonologically* marked structure. We argue that this explanation of the sequence of changes in (2) is superior to one based purely on the phonetic factors of articulation and perception.

In addition to these historical and theoretical issues, we provide a general overview of Banyaduq, as, to the best of our knowledge, there is no published information on the language. The structure of the paper is as follows. Section 2 provides general information and phonological background on Banyaduq that is relevant to the later discussion of prestopped nasals. Section 3 gives an overview of prestopped nasals crosslinguistically. Section 4 outlines the synchronic situation of prestopped nasals in Banyaduq, and section 5 discusses their diachronic context. Section 6 concludes.

2 Banyaduq

Before delving into the details of prestopped nasals in Banyaduq, it is important to first get an overall picture of the language and its phonology, especially aspects of the phonology which bear on the issues surrounding prestopped nasals. That is the purpose of this section. Section 2.1 first briefly describes the sociolinguistic situation of Banyaduq, and then sections 2.2 through 2.6 give an overview of phonological and phonetic facts that are relevant to the discussion of prestopped nasals in later sections. As most of our data comes from Sangke Banyaduq, this overview is focused on that particular dialect. However, as discussed in section 2.4, there appears to be significant variation in the phonologies of the different dialects. This variation bears on our understanding of the diachronic development of prestopped nasals discussed in section 5, and so it is discussed in this and subsequent sections to the extent that the available data allows.

2.1 Overview

Banyaduq is a Land Dayak language spoken in West Kalimantan province of Indonesia (Figure 1). It is primarily spoken in small villages along the border of Bengkayang and Landak regencies. As we already mentioned, our primary focus is on the dialect of Banyaduq spoken in the village of Sangke, the approximate location of which is indicated in Figure 1. Sangke Banyaduq is the

native language of one of the authors of this article (Kristian), who was born and raised in the village until attending boarding school for junior high school and high school. To the best of Kristian's knowledge, Banyaduq is spoken in the villages of Panchi', Kampet, Padang Pio, Untang, and Barinang Manyun in the north of Landak Regency and Sangke, Tapis Baru, Karasik Balantian, Engkayar, Gamang, and Temahar in the south. As detailed further below, we have also obtained wordlists of Banyaduq varieties in Panchi' and Temahar. No formal census of the total number of Banyaduq speakers exists, although Kristian estimates five to ten thousand speakers. Banyaduq displays some similarities to the Biatah (Kroeger, 2009) and the Bidayuh dialects (Rensch et al., 2012), better documented Land Dayak language varieties near and across the border with Malaysia. The language closest to Banyaduq on which there is published information is Bekati', although little exists about Bekati' besides word lists (for example, Hudson 1970). It should be noted that the Land Dayak languages are distinct from the neighboring Malayic Dayak languages (a distinction originally noted by Hudson 1970) and form a separate sub-branch of Malayo-Polynesian. A prominent Malayic Dayak language spoken in the areas near Banyaduq is Kanayatn (also known in the literature as Kendayan). Speakers of Banyaduq are also usually fluent in Kanayatn, but the reverse is not true.

Banyaduq is completely undocumented in the published literature. As far as the authors have been able to establish, previous work on the language consists solely of two unpublished word lists, each collected in one sitting by a researcher otherwise unfamiliar with the language. One was collected by Alfred Hudson in 1970, from a speaker from the village of Panchi', about twenty kilometers northwest of Sangke. Hudson lists the language documented as 'Banyaduq'. The other word list, of a language variety called 'Banyaduk', was collected in 2005 by Suhardi (working together with Uri Tadmor, then Director of the Jakarta Field Station of the Max Planck Institute for Evolutionary Anthropology) from a speaker from the village of Temahar, approximately ten kilometers to the east of Sangke. Hudson and Suhardi provided us with copies of their word lists, which allowed us to compare the differences among these closely related dialects. The relative positions of these towns and Ngabang, the principle town of Landak Regency, are given below in Figure 1. As will be discussed below, the data in these two lists differ in interesting ways from each other and from the data we collected. In general, the variety of Banyaduq recorded in Suhardi's list, henceforth 'Temahar Banyaduq', has a number of phonological differences from the variety spoken in Sangke (henceforth 'Sangke Banyaduq'), while the variety in Hudson's list (henceforth 'Panchi' Banyaduq') has fewer differences. These differences will be discussed in more detail in sections 2, 4, and 5, but we conclude that they are the result of geographic dialectal variation, and, as will be seen, are of value in understanding the diachronic development of Banyaduq.

The primary source for this article is data both elicited from Kristian, as well and data from other speakers from Sangke and nearby villages elicited and recorded by Kristian in Borneo. Much of this research was conducted in 2011 and 2012 while Kristian spent a year as a consultant and visiting student at the University of Delaware, with the sponsorship of the Fulbright FLTA Program. The recordings of other speakers in Sangke were made in the summer of 2011 before Kristian came to the University of Delaware. As we mentioned earlier, Kristian is a male who was raised in Sangke with Banyaduq as his primary language. Both of his parents were native Banyaduq speakers who received little formal education. He moved out of Sangke to attend junior high school, and as such is also educated in Indonesian. In addition, he is a fluent speaker of English. He was in his late twenties when the research for this paper was conducted.

<Figure 1>

Since Banyaduq has not been described previously in the literature, we shall attempt to present a

general picture of Banyaduq phonology, and will include the full range of phonetic data that is presently available.

2.2 Phoneme inventory

The following is the consonant phoneme inventory of Banyaduq. For reference, prestopped nasals are listed here as well, although as discussed in section 4.2, it is possible that they are sequences of independent stop and nasal phonemes (e.g., /pm/ may be a sequence of /p/ and /m/). In the stop series, segments appearing on the left are voiceless, while those on the right are voiced.

<Table 1>

Although they pattern phonologically as palatal stops, what we transcribe as /c, ɟ/ are often produced with affrication, and thus realized as either [cç, ɟʝ] or the alveolar [tʃ, dʒ]. This has little relevance to the phonetic and phonological questions central to this paper, so the examples here simply use the broad phonemic transcription /c, ɟ/.

Banyaduq has a simple five-phoneme vowel inventory: /i e a u o/. Nasalized vowels are only found as allophones of oral vowels and occur as a result of nasal harmony; this is discussed in section 2.5 below.

2.3 Banyaduq word structure

Leaving aside the issue of prestopped nasals, the structure of Banyaduq words is typical of languages in the region. Bisyllabic Banyaduq words are generally of the shape (C)V(N)(C)V(C), where N refers to nasal consonants and C to any consonant, nasal or otherwise (except when this would create an *NN sequence, which is not attested). In words of three or more syllables, syllables before the penult are usually of the shape CV. It is important to note that word-internal consonant sequences only consist of homorganic NC sequences; words of the shape *…VTNV… or *…VTTV…, where T may be any obstruent, are not attested. Additionally, palatals and voiced stops are prohibited word-finally, and the glottal consonants /ʔ/ and /h/ do not occur word-initially. Examples of word shapes, as well as corresponding unattested syllable types, are given below:

(3) a. [a.no] ‘go’/’day’ (*[ha.no])
b. [ka.bis] ‘dead’ (*[ka.bid])
c. [mã.kaʔ] ‘upwards’ (*[mat.kaʔ])
d. [ŋã.run.dam] ‘to hunt’ (*[ŋã.rul.dam])
e. [mãŋ.kan] ‘to give’ (*[mãm.kan])

Word-initial NC sequences are also possible, as the following forms attest. These are often, but not always, attributable to a nasal prefix or prefixes, which are common in the region (see e.g. Sneddon et al. (2010) for such morphology in Indonesian).

(4) a. [ŋkore] ‘to give (sth.) back’ (c.f. [ore] ‘to return (intrans) ‘)
b. [ɲɟaɟit] ‘to complete’ (c.f. [ɟaɟit] ‘completed’)
c. [ɲcagat] ‘to erect (trans.)’ (c.f. [cagat] ‘to stand up’)
d. [ntipatn] ‘scorpion’ *[tipatn]
e. [mbada] ‘very’ *[bada]
f. [ŋliliŋ] ‘around’ *[liliŋ]

Banyaduq words thus have a rather unremarkable structure when compared to other languages of the region. How prestopped nasals fit into this structure is an interesting question, one that will be discussed further in sections 4 and 5.

2.4 Dialectal variation

As mentioned above, while very similar, data from Sangke Banyaduq, the data in Temahar Banyaduq (Suhardi's word list), and the data from Panchi' Banyaduq (Hudson's word list) differ in some respects. There are three main differences between the lists as summarized below.

(5) Differences between the three sets of data:
  a. Some lexical items differ.
  b. Temahar and Panchi' Banyaduq have frequent word-medial *post*stopped nasals
  c. There are differences in the distribution of word-final *pre*stopped nasals (c.f. section 4.1.3)

Poststopped nasals, which have been lost in Sangke Banyaduq, will be discussed in section 2.4, where their relationship to nasal harmony is discussed. The differences in distribution of prestopped nasals are most relevant for the section 4 below, and so (5c) will be covered there in section 4.1.3. As for (5a), Suhardi lists a number of lexical items for Temahar Banyaduq which differ from those in our data and Hudson's list for Panchi' Banyaduq. Some examples (clearly not borrowed from Indonesian) are given below.

(6)	Temahar	Panchi'	Sangke	Indonesian
a. 'and'	gɛɛʔ	giʔ	[giʔ]	dan
b. 'name'	daan	gaat^{n}	[gaatn]	nama
c. 'swim'	kedanaŋ	baŋapɛk	[ŋãŋõŋõŋ]	bərənaŋ

The differences in (5) are interesting since they suggest that the three lists are somewhat different language varieties, although, as the majority of lexical items appear to be shared, these language varieties are very closely related. As the issue of shared lexical items has no other bearing on the questions at hand, we will not discuss it further in this article. In contrast, the differences in poststopped and prestopped nasals bear on both the synchronic and diachronic analyses given in sections 4 and 5, and as such are discussed as they become relevant throughout the paper.

2.5 Nasal harmony

As will be discussed momentarily, the development of prestopped nasals (at least in Austronesian languages and in some other families) is linked to progressive nasal harmony. Synchronically, Sangke Banyaduq has a rather simple process of nasal harmony, although the historical presence of word-medial prestopped nasals complicates the diachronic picture slightly. This section discusses both, starting with the synchronic facts of Sangke Banyaduq nasal harmony.

Like the classic example of Sundanese (Robins, 1953, 1957) and other neighboring languages, nasal segments in Sangke Banyaduq induce nasalization in a following vowel. This process continues left to right across the word, with nasalization spreading to subsequent glides and vowels. Crucially, all consonants except for /h/ block this spread:

(7) a. /nium/ → [nĩũm] 'smell'
  b. /mahe/ → [mãhẽ] 'to ask'
  c. /mahu/ → [mãhũ] 'female'

(8) a. /nele/ → [nẽle] 'to see'
  b. /murah/ → [mũrah] 'to enter'

c. /matoh/ → [mãtoh] ‘to throw’

Such nasal harmony processes are common in languages of the area, and, as will be discussed momentarily, the nasalization of final vowels is crucial to other researchers’ generalizations regarding prestopped nasals. The behavior of nasal harmony is no less important for our discussion of prestopped nasals in Sangke Banyaduq. As such, it is important to discuss a potential diachronic complication in the application of nasal harmony.

As noted in Adelaar (1992) in many languages of Borneo historical nasal-voiced stop sequences, or ‘poststopped’ nasals (henceforth abbreviated ND, where D is a voiced stop), have simplified to single nasals. The following examples are from Salako, a Malayic Dayak language spoken around the Malaysia/Indonesia border in northwestern Borneo (Adelaar 1992, p.386):

(9)	Proto-Malayic	Salako	Malay
a.	*əmbun ‘dew’	amutn id.	əmbun id.
b.	*mandiʔ ‘bathe’	maniʔ id.	mandi id.
c.	*tiŋgi ‘high’	tiŋi id.	tiŋgi id.

In, for example, (9b) ‘bathe,’ for which the Proto-Malayic form is *mandiʔ, the Salako reflex *maniʔ* has lost the medial *d (whereas Malay *mandi* has kept it). This loss can also be seen in the Land Dayak languages. Kroeger (2009) discusses this loss as being the subject of sociolinguistic variation in the Biatah dialects, listing ‘day’ as *əndu ~ ənu* and ‘take’ as *mbit ~ mit* (p. 119).

While Adelaar and Kroeger do not indicate vowel nasalization, a question arises: does nasal harmony apply to the vowel following the lost voiced stop, which would historically have blocked it? Court (1970), in discussing these processes in Land Dayak languages, emphatically says no: “When a voiced stop drops out … the nasal consonant never projects its nasality onto any following vowel” (p.205). Indeed, Rensch et al. (2012) list related Land Dayak languages where a potential nasal/oral vowel contrast has arisen due to loss of a consonant; they note, for example, in Bistaang the minimal pair [mɤ̃h] ‘padi field’ and [m(b)ɤh] ‘already’ (p. 63), although it is unclear to what extent the stop in the latter form has been lost.

What, then, is the case in Banyaduq? Based on differences between the word lists mentioned above and our Sangke data, it appears there is dialectal variation in the loss of ND sequences. The following forms compare word-medial nasals from forms in the three lists (Suhardi and Hudson did not transcribe vowel nasalization):

(10)	Temahar	Panchi’	Sangke
a. ‘mother’	sin^{d}o	sin^{d}oʔ	[sinõ]
b. ‘old’	am^{b}a	dama	[amã]
c. ‘day’	an^{d}o	an^{d}o~ano	[anõ]
d. ‘go’	ano	(not listed)	[anõ]
e. ‘sick’	an^{d}apm	(not listed)	[anãpm]

In both Temahar and Panchi’ Banyaduq, there are ‘post-stopped’ nasals, such as in (8b) *an^{d}o* ‘day.’ This appears to be a reflex of older ND sequences; for example, in Rensch et al. (2012)’s reconstruction, proto-Bekati’ (which is likely an ancestor of Banyaduq, or at least a closely related protolanguage) has *ando for ‘day’ (this is likely cognate with Kroeger’s /əndu/ ~ /ənu/ ‘day’ in Biatah). In contrast, our data shows [anõ] for this form, suggesting that in the Sangke variety of Banyaduq, the oral component in these ND sequences have been lost. That this loss is complete is evidenced by the fact that in Sangke Banyaduq (10c) ‘day’ and (d) ‘go’ are homophonous, whereas in Temahar they form the minimal pair *an^{d}o* and *ano*, respectively. Temahar Banyaduq clearly preserves an older distinction; in contrast to proto-Bekati’ *ando for

‘day’, Rensch et al. (2012) list *ano for ‘go’.

It should be noted that for Sangke Banyaduq there cannot be a synchronic process deleting an underlying D from ND sequences as, for example, Scott (1964) and Court (1970) posit. Our data have clear ND sequences in other forms:

(11) ND sequences in Sangke Banyaduq

a. [ŋãrundam]	‘to hunt’	*[ŋãrunãm]	c. [mbada]	‘very’	*[mãda]
b. [ɲãnduʔ]	‘not’	*[ɲãnũʔ]	d. [bakambaŋ]	‘to grow’	*[bakamãŋ]

As far as we can discern, these are not loans (the name ‘Banyaduq’ is etymologically related to (11b)) and thus not candidates for special loan phonology, so we reject an analysis in which D deletion following an N is synchronic. At present it is unclear why these ND sequences have not been lost as in the examples in (10); this may be clarified by further historical work on the protoforms of the examples in (11) and their morphology.

Finally, at least in Sangke Banyaduq, nasal harmony occurs even after a ND sequence that has diachronically simplified to N. While we have not conducted a detailed phonetic study, at least impressionistically, the last vowels in all the forms in (10) are nasalized. These impressions are confirmed by the fact that, if nasal harmony *were* blocked after a historic D, (10c) ‘day’ and (d) ‘go’ should still contrast, because ‘day’ should be pronounced *[ano] (c.f. proto-Bekati’ *ando), while ‘go’ is [anõ] (parallel to Rensch et al. (2012)’s [mɤ̃h] ‘padi field’ and [m(b)ɤh] ‘already’ in Bistaang). However, they do not; as mentioned above, in Sangke these are homophonous. We thus conclude that nasal harmony is completely predictable in Banyaduq.

2.6 Prestopped nasals

We give here an overview of the distributional and phonetic properties of prestopped nasals in Sangke Banyaduq. A prestopped nasal is a nasal stop pronounced with a preceding homorganic oral occlusion. As mentioned in the introduction, their synchronic and diachronic status is of particular interest, and so we return to these points in sections 5 and 6. These sections also discuss dialectal variation that we discovered among the three varieties of Banyaduq.

In Banyaduq, prestopped nasals occur across lexical categories, occurring in nouns, verbs, and adjectives. They are attested with labial, alveolar, and velar places of articulation; however, although palatal stops and nasals do exist in the language, palatal prestopped nasals (e.g., [cɲ]) are not attested. The oral portion is without exception voiceless (as shall be discussed below in section 3, this contrasts with prestopped nasals in some other languages in the region). Prestopped nasals only occur word-finally, although plain nasals also appear in word-final position (and elsewhere).

(12) Banyaduq prestopped nasals at labial, alveolar, and velar places of articulation

[pm]	[tn]	[kŋ]
a. [asupm] ‘mango’	e. [ikatn] ‘fish’	i. [barekŋ] ‘hand’
b. [mõrupm] ‘to fly’	f. [mototn] ‘farming highlands’	j. [idukŋ] ‘nose’
c. [anãpm] ‘sour, sick’	g. [matatn] ‘to throw away’	k. [dinĩkŋ] ‘wall’
d. [ŋahapm] ‘yawn’	h. [ntipatn] ‘scorpion’	l. [apakŋ] ‘back’

Only a preliminary acoustic study has been carried out on Banyaduq prestopped nasals, and only with respect to a single speaker of Sanke Banyaduq (Kristian). While caution is advisable, we have no reason to think that the data we have collected is atypical in any way, and since Banyaduq is otherwise undescribed, we include phonetic data based on a single speaker.

The oral occlusion generally has a small release into the nasal stop. A spectrogram of the word-final [tn] sequence of (12e) [ikatn] ‘fish’ can be seen in Figure 2 below:

<Figure 2>

The oral portion is voiceless, as seen by the lack of a voicing bar, with a slight release into the nasal. It is clearly an uninterrupted sequence of two consonantal gestures; no hint of vowel formants can be seen between them. The nasal stop is of slightly longer duration than the oral occlusion. This can also be seen for [pm] and [kŋ] prestopped nasals in the spectrograms for (12l) [apakŋ] 'back' and (12d) [ŋahapm] 'yawn' given below in Figures 3 and 4, respectively.

<Figure 3>

<Figure 4>

2.6.1 Duration of prestopped nasal gestures

The data we collected include a preliminary comparison of duration measurements of the oral and nasal portions of a prestopped nasal, comparing these measurements with their respective counterparts in 'plain' oral and nasals stops (with the understanding that these measurements will require confirmation from a larger sample). This comparison is of particular relevance for us because it has been argued by Riehl (2009) that such duration measurements are important in deciding the question of whether a particular sequence of gestures belong to one segment or a sequence of segments. (She finds that other phonetic characteristics, specifically nasalization and duration of a preceding vowel, not to be relevant.) As mentioned above, whether Banyaduq prestopped nasals are single segments or sequences of segments is an interesting question, and so we find it of interest to provide this phonetic information (though we do not necessarily agree—as is discussed further in section 4.2—that phonological status is invariably a direct reflection of the phonetic facts).

The following is based on the averages of 50 tokens collected in the carrier sentence *Ikin ŋucap kata ____ kaʔ Adam* ('I said the word ____ to Adam') featuring the surface voiceless oral closure [t] and nasal stop [n]. They were recorded in two sessions at the University of Delaware, as part of a larger collection of recordings to gather general phonetic measurements. All recordings and measurements were done in Praat (Boersma and Weenink 2013). The alveolar gestures [t] and [n] (we use 'gesture' to remain agnostic as to whether the [t] and [n] portions of the prestopped nasals are each segments in their own right) were chosen as opposed to [p]/[m] or [k]/[ŋ] pairs because [p] has a low lexical frequency in our elicitations, and [k] often alternated word-finally with [ʔ]. For a prestopped [tn] sequence, the portion of the spectrogram in between the preceding vowel formants and the nasal formants (and, if present, voicing bar of the nasal), was judged to be a [t]. The border between the [t] and [n] gesture was taken to be at the first positive zero crossing of the first cycle in the waveform associated with the acoustic energy of the nasal formants. Similarly, for word final [n] gestures the end of the gesture was marked at the last negative zero crossing of the last cycle in the waveform associated with the acoustic energy of the nasal formants. Judging the end of word-final [t] gestures was considerably more difficult. However, in the tokens used, there was a burst of high frequency noise indicating a transition to the following [k] (in *kaq*), which was taken to indicate the boundary between [t] and [k].

For [t], there were a total of 31 tokens. Seven tokens featured the gesture in initial position ([#t]), seven in word final position ([t#]), seven in a word-final prestopped nasal ([tn]), and ten were in vowel-medial position ([VtV]). For [n], there were a total of 26 tokens. Five tokens featured the gesture in initial position, seven in word-final position, seven in prestopped nasals (the same [tn] tokens were used for both [t] and [n] measurements), and seven in word medial position.

The average duration of these gestures are as in Table 2. For a full list of the forms used

and the duration measurements for each token, please see the appendix.

<Table 2>

While we were unable to collect enough data to do a full statistical analysis, there are some general patterns in the averages. As can be seen from Table 2, the oral portion [t] of [tn] prestopped nasals was, on average, 148ms, which is more comparable in length to the initial (120 ms) and inter-vocalic (140ms) instances of [t] than to word-final instances of [t] (60 ms). The opposite was found for the nasal portion of [tn] prestopped nasals. This [n], with an average duration of 132 ms, was closer in duration to word final [n] tokens (143 ms) than to initial (91 ms) or inter-vocalic (72 ms) [n] tokens. The total length of prestopped [tn] tokens was on average 279 ms, was much longer than the averages for single [t] or [n] stops.

We emphasize that these measurements are based on a small number of tokens, and the nature of our work precludes a conclusive statistical study. However, the averages given here do suggest that the durations of the [t] and [n] gestures of prestopped nasals are comparable to the durations of single /t/ and /n/ segments elsewhere in Banyaduq words.

2.6.2 Optional nasal deletion

Of particular interest is the fact that the nasal portion of prestopped nasals is not always pronounced. For example, 'fish' is pronounced variously as [ikatn] and [ikat]. This variation is common in younger speakers of the language. This is a case of free variation; we did not find the alternation to have any morphological or phonological conditioning. For example, either pronunciation of 'fish' is possible regardless of the concatenation of the suffix /e/ '3SG.POSS/DET' or /koʔ/ '1SG.POSS'. This and other examples of free variation are given below in (13) (forms with the unpronounced nasal portion are in the second column).

(13)	a. [ikatn-e]	[ikat-e]	'his fish/the fish'
	b. [ikatn-koʔ]	[ikat-koʔ]	'my fish'
	c. [dinikŋ-e]	[dinik-e]	'his wall/the wall'
	d. [anãpm abako]	[anãp abako]	'headache' ('sick'+'head')

It should be noted that such alternations raise the possibility of homophony with forms ending in simple oral stops. However, we have thus far discovered few examples of this actually occurring. One possible instance is [ikat] 'bunch', with which [ikatn]~[ikat] 'fish' would become homophonous. However, this is identical to the Indonesian form *ikat* id., and may thus be a recent borrowing. Future work can search for more of such pairs, and phonetic and perceptual studies can test whether they are truly homophonous.[2]

From a diachronic perspective, these alternations are very interesting, as will be discussed further in section 5. For brevity, we will refer to this process throughout this paper as 'optional nasal deletion', although we stress that it only applies to the nasal portion of prestopped nasals. As will be revisited in section 5 of this paper, to the best of our knowledge this is the first documentation of a synchronic alternation between prestopped nasals and oral stops (as shall also be discussed in that section, there also appears to be a diachronic link between prestopped nasals and oral stops).

Our review of recordings of conversations among older Sangke speakers showed that they more consistently pronounce the nasal portion of prestopped nasals, although deletion did occasionally occur, particularly in reduplicative forms. One example of such an alternation from our recordings is as follows:

[2] These points and example are due to Abigail Cohn.

(14) a. [ikatn taŋkeokŋ]
fish tangkeokng (kind of fish)
'tangkeokng fish'
b. [ikat taŋkeok ikat taŋkeok]
'tangkeokng fish (emphasis)'

As for the sociolinguistic nature of this nasal loss, the nature of our work so far has made a large-scale statistical study impossible, but we hope in future studies of naturalistic speech to examine the frequency with which speakers drop the nasal portion of prestopped nasals, taking into account phonological/morphological environment and sociolinguistic variables such as age and place of birth of speaker. It may likely be that frequency of optional nasal deletion may be correlated with education in Indonesian, which does not have prestopped nasals (Sneddon et al. 2010).[3]

2.7 Summary of phonological and phonetic facts

This section established the general phonological and phonetic facts of Banyaduq which will be relevant to the discussion of prestopped nasals, the main focus of this paper. These facts are summarized in (15) below:

(15) Relevant facts for Banyaduq
a. Left to right nasal harmony is predictable and blocked by all consonants except for /h/ (section 2.5; c.f. (7a) /nium/ → [nĩũm] 'smell' vs. (8a) /nele/ → [nẽle] 'to see')
b. Banyaduq has word-final prestopped nasals which, for some speakers of Sangke Banyaduq, can be optionally pronounced as oral stops
c. The relevant phonological facts are subject to some dialectal variation in Banyaduq (sections 2.4, 2.5, and to be discussed in sections 4 and 5)
d. Preliminary acoustic measurements indicate that the individual oral and nasal gestures of prestopped nasals are comparable in duration to that of single oral and nasal segments. The total length of prestopped nasals are much longer in duration than word-final single oral and nasal segments.

Before discussing the synchronic and diachronic situations of prestopped nasals in Banyaduq, it will be useful to first discuss other work on prestopped nasals in related languages.

3 Prestopped Nasals Cross-Linguistically

Nasal prestopping is a well-documented phenomenon, particularly in an around Borneo. Blust (1997) provides a brief survey of prestopped nasals, citing eight attestations of prestopping in Austronesian languages in Borneo, Sumatra, Thailand, and the Philippines. He also discusses occurrences in Austroasiatic and Australian languages. Since his work, prestopped nasals in other Austronesian language varieties have been described as well. For example, in Jambi Malay (Durvasula 2009, Yanti 2010), a dialect of Malay spoken in the area surrounding Jambi City in central Sumatra, some words which have word-final 'plain' nasals (nasals without prestopping) in phrase-medial position appear with word-final prestopped nasals in phrase-final position. In Jambi Malay, the oral portion of prestopped nasals is voiced.

(16) Jambi Malay (Yanti, 2010, p. 655 (41))

[3] Thanks to Michael Boutin for raising this point.

			Phrase medial	Phrase final
a.	/malam/	‘night’	[mãlam]	[mãla^{b}m]
b.	/lapan/	‘eight’	[lapan]	[lapa^{d}n]
c.	/batrɒŋ/	‘k.o. fish’	[batrɒŋ]	[batrɒ^{g}ŋ]

Blust notes that Austronesian prestopped nasals display an interaction with nasal harmony. In the languages he surveys, prestopping of a nasal occurs word-finally following an oral vowel; this process is blocked when nasal harmony causes the preceding vowel to be nasalized. He quotes a Boutin and Howery (1991) article on Bonggi, a language of the Sabah, Malaysia: “Bonggi prestopped nasals occur when the preceding vowel is nonnasalized” (Boutin and Howery 1991, p. 315, quoted in Blust 1997, p. 156).

Yanti’s (2010) description accords with this generalization. In (16), the prestopped nasals all follow oral vowels. As the following data show, nasalization spreads to a final vowel, and alternations like in (16) are disallowed:

(17) Jambi Malay (Yanti, 2010, p. 655 (42))

a. /minum/	‘drink’	[mĩnũm],	*[mĩnũ^{b}m]
b. /taŋan/	‘hand’	[taŋãn],	*[taŋã^{d}n]
c. /kuniŋ/	‘yellow’	[kunĩŋ],	*[kunĩ^{g}ŋ]

In (16a) /malam/ ‘night,’ nasalization spreads from the initial /m/ to the following /a/, but does not proceed past the /l/. The final /a/ remains oral, and thus we see the [mãlam] ~ [mãla^{b}m] alternation on the surface. In contrast, the /u/ in (17a) [mĩnũm] ‘drink’ is nasalized, and so there is no alternation.

As indicated, Yanti (2010) analyzes prestopped nasals as allophones of their ‘plain’ counterparts. While she does not formalize a rule, she explicitly states that the prestopped nasals derive synchronically from word-final nasals after a non-nasalized vowel. This is typical of the treatments of Austronesian prestopped nasals in the literature, including the better-studied Land Dayak languages spoken across the Malaysian border from where Banyaduq is spoken. Perhaps the best known of these is Scott’s (1964) analysis of prestopping in Bukar-Sadong, which Anderson (1976) cites as evidence that phonological rules need to be able to operate within segment boundaries. Rensch et al. (2012), surveying the phonologies of the Bidayuh language varieties (for which they include Bukar-Sadong and Biatah), similarly treat prestopped nasals in those language varieties as allophones of plain nasals. Kroeger (2009), writing on the Biatah dialects south of Kuching, Malaysia, indicates that for these varieties this allophony is subject to sociolinguistic variation: “[W]hen speaking to outsiders, many educated speakers tend to adopt a ‘spelling pronunciation’ (or ‘foreigner talk’) in which all such pre-plosion [i.e., prestopping] is suppressed” (p.118). Kroeger also notes that prestopping “is very slight and difficult to hear in the speech of some speakers” and “in general the pre-plosion gets stronger the farther one gets from Kuching…[t]hus in the Upper Padawan dialect, final [prestopped] nasals are preceded by a voiceless stop” (p. 118).

Thus, for other Land Dayak languages, prestopped nasals are synchronically allophones, deriving from an automatic process which affects any word-final nasal following an oral vowel. We give evidence that, at least for Sangke Banyaduq, the synchronic status of prestopped nasals is substantially different from those in the language varieties just discussed. We reach this conclusion based on the presence of numerous forms in which plain nasals follow oral vowels (i.e., the environment in which prestopping would be expected if it were synchronic), as well as some in which prestopped nasals follow nasalized vowels (i.e., the environment in which prestopping should be blocked). This conclusion and evidence are presented in detail in the following section.

4 The Synchronic Status of Prestopped Nasals in Banyaduq

4.1 The phonemic status of prestopped nasals in Banyaduq

The analyses in the literature discussed in section 3 would appear at first glance to suggest that Banyaduq prestopped nasals should also be analyzed as allophonic variants of underlying plain nasals. Avoiding a specific theoretical framework, (18) informally summarizes the cross-linguistic generalization other researches have posited for Austronesian prestopped nasals, as just discussed in section 3:

(18) Nasal Prestopping Generalization (NPG):
Plain nasals are prestopped word-finally following an oral vowel.

We will first show that the NPG is not an across-the-board process in Banyaduq (as, for instance, it appears to be in Jambi Malay). This section shows that interpreting the NPG as synchronically active in Sangke Banyaduq makes incorrect predictions, and thus Sangke Banyaduq prestopped nasals are phonologically distinct from other prestopped nasals in the region. We also present data showing that this conclusion does not hold for all dialects of Banyaduq.

4.1.1 Predictions of the NPG

Recall from section 2.4 that nasal segments initiate a nasal harmony process which applies left to right across a word. The following examples are repeated from (7) and (8) above; an example of nasal harmony through a laryngeal segment can be seen in (19a), and (19b) shows a non-laryngeal consonant blocking nasal harmony to a final vowel:

(19) a. /mahu/ → [mãhũ] ‘female’ (=5b)
b. /matoh/ → [mãtoh] ‘to throw’ (=6c)

Given the facts of Sangke Banyaduq nasal harmony, analyzing Sangke Banyaduq prestopped nasals as allophones of plain nasals derived through the NPG defined in (18) predicts a complementary distribution of plain and prestopped nasals:

(20) a. Word-finally, plain nasals are predicted to be found only when nasal harmony has reached the final vowel. This situation is expected to occur only when a nasal segment is found earlier in the word, and no blocking consonants occur between this nasal segment and the final nasal.

b. Prestopped nasals are predicted to occur only after an oral vowel. Oral vowels, in turn, are expected to occur only when either there are no nasal segments earlier in the word to initiate nasal harmony, or when an intermediate blocking segment prevents any nasal harmony from reaching the final vowel.

A fair number of forms in Sangke Banyaduq are in accord with these two predictions. The forms in (21) conform to (20a) and the forms in (22) and (23) conform to (20b):

(21) Plain nasals following a nasalized vowel
a. [nĩũm] ‘smell’
b. [gunõŋ] ‘mountain’
c. [mãntimũn] ‘cucumber’
d. [banũn] ‘husband’
e. [mũɲũŋ] ‘to sit’

f. [anãm] ‘six’

(22) Prestopped nasals following an oral vowel (no nasal harmony)
a. [asupm] ‘mango’
b. [itapm] ‘black’
c. [gurikŋ] ‘to lie down’

(23) Prestopped nasals following an oral vowel (nasal harmony blocked)
a. [mãtatn] ‘to throw away’ b. [ntipatn] ‘scorpion’
c. [mõrupm] ‘to fly’ d. [nãbukŋ] ‘to cut horizontally’

Despite the existence of many examples that conform to the NPG, the predictions in (20) are not correct for all forms in Sangke Banyaduq. The NPG makes wrong predictions for a number of native Banyaduq words, as well as for loanwords from Indonesian.

4.1.2 Native Banyaduq vocabulary

The following forms are of native Land Dayak stock, but contradict the predictions in (20). First, a small number of words have prestopped nasals after a nasalized vowel, in contradiction to the prediction of (20a):[4]

(24) a. [dinĩkŋ] ‘wall’ *[dinĩŋ]
b. [anãpm] ‘sick’ *[anãm]
c. [paruŋãkŋ] ‘mosquito’ *[paruŋãŋ]
d. [taɲũkŋ] ‘land’ *[taɲũŋ]
e. [tumãkŋ] ‘fall down’ *[tumãŋ]
g. [ŋãhãpm] ‘yawn’ *[ŋãhãm]

More numerous are contradictions to the prediction in (20b), in which a plain nasal follows an oral vowel:

(25) a. [akum] ‘second person pl.’ *[akupm]
b. [ŋãrum] ‘night’ *[ŋãrupm]
c. [ikin] ‘first person singular’ *[ikitn]
d. [nekoŋ] ‘to turn’ *[nekokŋ]
e. [ɲãraŋ] ‘to attack’ *[ɲãrakŋ]
f. [sosoŋ] ‘breast’ *[sosokŋ]
g. [mãŋkoŋ] ‘to hit’ *[mãŋkokŋ]
h. [mãŋkan] ‘to give’ *[mãŋkatn]
i. [ŋãrundam] ‘to hunt’ *[ŋãrundapm]
j. [bakambaŋ] ‘to grow’*[bakambakŋ]
k. [ŋũndaŋ] ‘to invite’ *[ŋundakŋ]

Especially telling exceptions are (25b) [ŋãrum] ‘night’, which forms a near-minimal pair with (23c) [mõrupm] ‘to fly,’ and (24b) [anãpm] ‘sick’, which forms a minimal pair with (21f) [anãm] ‘six’. No (exceptionless) rule can account for both pairs of forms.

4.1.3 Dialectal variation and the distribution of prestopped nasals

[4] As to be discussed momentarily, it is most likely that, historically, most of these forms had medial ND clusters, e.g. (24) [anãpm] ‘sick’ > *anapm. This raises the possibility, discussed in Section 2.5, that nasal harmony has been blocked in these final vowels. However, we assert that they are nasalized. As stated in Section 2.5., we have not conducted a detailed phonetic study, but the impressions and intuitions of the authors are that they are indeed nasalized. Furthermore, Section 2.5 presented other evidence that vowels following historical *ND clusters are nasalized in Sangke Banyaduq—in particular, the merger of (10c) [anõ] ‘day’ < *ando with (10d) [anõ] ‘go’ < *ano.

It should be noted here that the wordlists from varieties other than Sangke provide evidence for dialectal variation in the pronunciation of the forms in the above section. First, for two of the forms in (24), Temahar Banyaduq has word-medial *post*stopped nasals. These are listed below for comparison.

(26)	Temahar	Panchi'	Sangke
a. 'sick'	an^{d}a^{p}m	(not listed)	[anãpm]
b. 'mosquito'	paruŋ^{g}a^{k}ŋ	paruŋak^{ŋ}	[paruŋãkŋ]

The presence of the word-medial poststopped nasal changes the predictions of the NPG for Temahar (26a) *an^{d}a^{p}m* 'sick'. The oral occlusion [^{d}] following the medial [n] blocks nasal harmony, and thus the prestopped [^{p}m] is expected. Indeed, this is clearly the historical source of the unexpected prestopping in Sangke Banyaduq—Rensch et al. (2012) reconstruct proto-Bakati as having *andam 'sick, hurt' (p. 215). However, as established in section 2.5, poststopped nasals have been lost in Sangke Banyaduq, leaving medial nasals in forms like in (26) to nasalize the final vowel, and thus the prestopping is left synchronically unexplained. This appears to be the case for the Panchi' variety as well. An opaque, serial analysis of the NPG based on this historical development is discussed, and ultimately rejected, in section 4.1.5 below. As far as we can ascertain from our work and others' work on related languages, these forms appear to be monomorphemic, so a morphophonological explanation seems also unlikely at present.

Temahar Banyaduq also differs from Sangke and Panchi' Banyaduq for the forms from (25) shared between the lists; Temahar consistently has prestopped nasals where Sangke and Panchi' do not. For example, (27b) 'night' is *ŋaru^{p}m* in Temahar and (27c) '1SG' is *iki^{t}n*. In contrast, Hudson's Panchi' Banyaduq data agree with our Sangke Banyaduq data. For example, 'night' is *ŋarum* and '1SG' is *ikin* in both dialects. A brief list of the forms in question follows in (27):

(27)		Temahar	Panchi'	Sangke
a. 'night'		ŋaru^{p}m	ŋarum	[ŋãrum]
b. '1SG'		iki^{t}n	ikin	[ikin]
c. '2PL'		aku^{p}m	akum	[akum]
d. 'stab'		nika^{p}m	nanikam	[nĩkam]
e. 'hit'		maŋka^{k}ŋ	batindʒu	[mãŋkoŋ]
f. 'give'		(not given)	maŋkan	[mãŋkan]
g. 'breast'		soso^{k}ŋ	(not given)	[sosoŋ]
h. 'cat'		uci^{k}ŋ	uciŋ	[kuciŋ]

The Panchi' forms in (27) are not simply due to mistranscription. According to Hudson (p.c.), after eliciting unexpected plain nasals he checked with his speaker, who specifically said that they were pronounced without the prestopping. For example, his speaker pronounced (27h) 'cat' as *uciŋ* and specifically stated that *uci^{k}ŋ* was the Bekati', and not Banyaduq, pronunciation.

It thus appears that in the data for Temahar Banyaduq, the NPG makes the correct predictions, while it does not for Sangke or Panchi' Banyaduq. The natural conclusion is that in some varieties of Banyaduq, nasal prestopping is still synchronically active, while in others it is not. Such dialectal variation is natural (see, e.g., Labov 1994), and the relevance of this dialectal variation for the diachronic situation of prestopped nasals will be discussed momentarily in section 5.

4.1.4 Loans from Indonesian

As one additional piece of evidence that the NPG is not synchronically active in Sangke Banyaduq, we note that the NPG makes incorrect predictions for forms in the dialect apparently borrowed from Indonesian, which does not have prestopping (Sneddon et al, 2010). While loanwords do not necessarily have to conform exactly to a language's phonology (see, for example, Ito and Mester 2009 on the different behavior of loan strata in Japanese, or Orgun 1996 and Anttila 2002 for differing 'cophonologies' operating within the same language), we take this as further evidence that the NPG no longer has psychological reality as an automatic phonetic process in Sangke Banyaduq.[5]

The following examples end in plain nasals that follow an oral vowel. The following items are taken exclusively from naturalistic data of older speakers' speech in Sangke.

(28) a. [kampoŋ] 'village' (Indonesian: kampuŋ)
b. [bidan] 'midwife' (Indonesian: bidan)
c. [benãtaŋ] 'animal' (Indonesian: binataŋ)
d. [kuciŋ] 'cat' (Indonesian: kuciŋ)

4.1.5 Alternative analyses

The exceptions in (24) and (25) make it clear that orality in the preceding vowel—which we saw in section 2 to be a common phonetic cue for prestopped nasals in related languages—is not sufficient to predict prestopped nasals in Sangke Banyaduq. The following discussion considers a few alternative analyses of Sangke prestopped nasals as allophonic and explains why all are problematic, reaching the conclusion that the NPG is not synchronic in Sangke Banyaduq and that prestopped nasals must be represented in the underlying representation.

For the forms in (24), which have unexpected prestopped nasals after a nasalized vowel, one possible explanation, based on the historical form, is an opaque, serial interaction where forms like (24b) [anãpm] 'sick' are underlyingly /andam/, and a post-medial /d/ is deleted after some prestopping generalization applies. This is the analysis is given by Scott (1964) in his discussion of Bukar-Sadong. However, such an analysis fails in Sangke Banyaduq. As (29) below shows, this ordering incorrectly predicts an oral second vowel in (24b) [anãpm] 'sick'. In (29), a hypothetical analysis is given in which prestopped nasals in (22b) [itapm] 'black' and (24b) [anãpm] are derived via NPG from plain nasals in /itam/ and /andam/, respectively. For contrast, a derivation for (21d) [banũn] 'husband,' which ends in a plain nasal, is also given.[6]

(29)

	/itam/ (=22b)	/banun/ (=21d)	/andam/ (=24b)
Nasal harmony	---	banũn	---
Post-N Stop Del.	---	---	anam
NPG	itapm	---	anapm
Surface	itapm	banũn	*anapm

Furthermore, any medial voiced stop deletion rule would make the wrong predictions for the

[5] As Indonesian and Banyaduq are cousin languages, it is not always clear whether a Banyaduq form has been borrowed or is a native word that is accidentally identical to the Indonesian. In fact, the situation is complicated because in addition to standard and local varieties of Indonesian, local Malayic Dayak languages abound in the region. Thus, the source of borrowings is less than obvious. Furthermore, as loanword phonology often differs from the phonology of native forms, for the purposes of our argument it is more conservative to treat forms whose origin is questionable as loans from a non-prestopping Malayic isolect than it would be to treat them as indigenous to Banyaduq.

[6] Reversing the order of the NPG and nasal harmony would correctly derive [anãpm] from /andam/. However, this predicts prestopping in *every* word-final nasal, and would incorrectly derive *[banũdn] from /banun/.

forms in (18), repeated below in (30), which have voiced stops following nasals:

(30) Nasal-voiced stop sequences in Sangke Banyaduq
a. [ŋarundam] ‘to hunt’ c. [ɲundaŋ] ‘to invite’
b. [ɲanduʔ] ‘not’ d. [bakambaŋ] ‘to grow’

Finally, there are no alternations to justify such an underlying form. For example, in no situation is *[andapm] a possible pronunciation of (24b) ‘sick’. A derivation like (29), then, is untenable for Banyaduq. Furthermore, such a derivation would not explain the exceptions from (25) with final plain nasals following a vowel.

One last possible predictor for the distribution of prestopped nasals might be suprasegmental. This is not plausible, however, as Banyaduq has neither contrastive stress nor tone. It is beyond the purview of this paper to discuss whether Banyaduq has stress at all, but descriptively, final vowels are consistently pronounced with slightly higher duration and intensity. For example, the final [u] is prominent in both (25b) [ŋãrum] ‘night’ and (23c) [mõrupm] ‘to fly.’ Stress cannot, then, provide an explanation for why only the latter has a prestopped nasal. Thus, consistent triggers do not exist, either segmentally or suprasegmentally, which could justify positing an NPG-like explanation for the distribution of plain and prestopped nasals.

While the exceptions in (24) and (25) show that an across-the-board interpretation of the NPG is untenable for Sangke Banyaduq, it is technically possible to solve this problem by relegating the rule to some subset of the lexicon, thereby making the apparent counterexamples irrelevant. This would be akin to the cophonology approach of Orgun (1996) and Anttila (2002), in which different subsets of the lexicon follow different phonological generalizations. This proposal, however, suffers from a lack of motivation. Three subsets would be needed; one subset in which the NPG is active, one subset in which it is *not* active, to handle the exceptions in (25) in which plain nasals follow an oral vowel, and one for the exceptions in (24) in which prestopping *also* occurs after a nasalized vowel. The chart in (31) summarizes these subsets, with examples:

(31) Subset:	Example members:
NPG active	(21a) [nĩũm] ‘smell’, (23c) [mõrupm] ‘to fly’
NPG blocked	(25b) [ŋãrum] ‘night’, (28d) [kuciŋ] ‘cat’
NPG after nasalized vowels	(24b) [anãpm] ‘sick’ (24g) [ŋãhãpm] ‘yawn’

There is, so far as we can determine, no further empirical evidence for the existence of these lexical subsets. There are no morphological characteristics particular to any of them, and no other phonological generalizations depend on them. As such, a learner acquiring the language would have to memorize to which subset each word belongs, as well as the different phonological generalizations for each subset. We find it much more plausible that these final prestopped nasals are simply present in the underlying forms, without needing recourse to lexical subsets and subset-specific phonologies. Thus, we find that there is no justification for creating separate cophonologies just for these exceptions.

4.1.6 Interim conclusion: Prestopped nasals are phonemic in Sangke Banyaduq

To conclude, the NPG as stated in (18), which functions as a synchronic rule to derive prestopped nasals from plain nasals in such languages as Jambi Malay, is insufficient with respect to the facts of Sangke Banyaduq. Phonetically, Banyaduq prestopped nasals occupy the same environments as plain nasals. Furthermore, as argued in section 4.1.5, explaining prestopped nasals through lexical substrata is not only unmotivated empirically but also does not go far in predicting the distribution of prestopped nasals. Banyaduq prestopped nasals, then, are in contrastive, not complementary, distribution with plain nasals. This is highlighted by the minimal

pair (24b) [anãpm] ‘sick’ and (21f) [anãm] ‘six,’ originally given in section 4.1.2.

4.2 The nature of Sangke Banyaduq prestopped nasals in the underlying representation

Having established that prestopped nasals must be represented in some way in the UR, the issue arises of how to represent them. To use [tn] as an example, it might be underlyingly /t^n/—one consonant with both [–] and [+] values for the feature [nasal].[7] A feature geometric diagram (Clements 1985, Sagey 1986) of such a structure is given in Figure 5 below. Another possibility, however, is that the two distinct oral and nasal phases in the surface form each correspond to a separate phoneme in the underlying form. Thus, [tn] would be /tn/ underlyingly. As it turns out the evidence is mixed: We give evidence for both approaches, but leave a firm answer to this question for later research. However, an important conclusion of this section is that regardless of whether Sangke prestopped nasals are underlying sequences or single segments, they complicate the phonology of the language, a fact that will play into our diachronic analysis in the following section.

<Figure 5>

In order to determine the correct underlying representation we must first determine what evidence is relevant to the phonological representation, a question that remains controversial. Different authors espouse different answers to this question. For example, Riehl (2008) argues that phonetic measurements provide direct evidence for underlying representations, and that “there is a direct mapping between the segmental structures in the phonology and their phonetic realizations” (p.332). In a contrasting view, François (2010) states that “[t]he phonetic properties of each phase [of a complex segment]—timing, intensity, formant transitions, etc.—do not necessarily mirror the emic features which are relevant to account for their phonological behaviour in the system” (p. 404). On the latter view, the phonemic status of segments should be determined purely by the overall patterning of the phonological system. In the interest of inclusiveness, we therefore give a brief overview of both phonetic and phonological evidence. Our final conclusion will be that the phonetic evidence appears to favor the sequence analysis but evidence from phonological patterning is inconclusive. Thus, it is difficult to reach a clear conclusion regarding which analysis is to be preferred since it largely depends on the theoretical predilections of the analyst.

From the phonetic point of view, Riehl (2008)’s work is an appropriate starting point, as it deals with the similar question of the unit versus cluster status of NC sequences in several Austronesian languages. She specifically interprets the direct mapping from phonology to phonetics to make predictions about duration: phonologically single segments are necessarily shorter than clusters of two segments. For the languages she studied, she finds these predictions to be borne out, and that “it is the relationship between the duration of a plain nasal and of an NC sequence that is the most informative…” (p. 264-5).

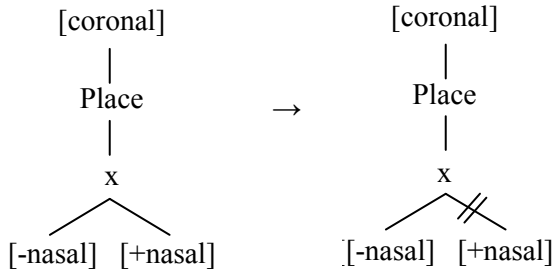
If we bring this line of reasoning to bear on Banyaduq prestopped nasals, the /t^n/ and /tn/ analyses thus make different predictions with regard to the duration of prestopped and plain nasals. Analyzing [tn] as a single complex segment, /t^n/, underlyingly, thus, predicts its entire duration to be comparable to that of a single segment, e.g. [n] derived from a plain /n/. In contrast, positing that [tn] is underlyingly a sequence of two segments, /tn/, predicts the duration of the [n]

[7] There are three possibilities for denoting a single, complex prestopped nasal phoneme: /^{t}n/, /t^n/, or /$\widehat{tn}$/. We consider /t^n/ to be the strongest candidate of these; for one, only the oral portion is invariably pronounced (c.f. the optional nasal deletion process in Section 2.6.2), and thus use it as a representative. However, the arguments in this section apply to any of these possible representations.

portion of the sequence alone to be comparable to [n] derived from /n/.[8] The preliminary duration measurements discussed in 2.5.1 are consistent with the second prediction: prestopped [tn] were found to be much longer than word final plain [n] nasals, with the component [t] and [n] portions of the prestopped nasal comparable in duration with their unit segment counterparts elsewhere in the word. Thus, if we are to adopt Riehl's hypothesis of a direct mapping between phonological status and phonetic duration, and if the phonetic facts for additional speakers are similar to what we have found so far, it would follow that prestopped nasals are underlyingly sequences.

However, it is also important (or, as François argues, even more important) to look for evidence from phonological patterning to determine the choice between /t^n/ and /tn/. From this perspective, the key is to ask which analysis allows for a more insightful description of the overall phonological system. In the case of Banyaduq, this is a particularly difficult question to answer. For example, the only alternation in which prestopped nasals participate is the optional nasal deletion process, discussed in section 2.5.2, in which underlying prestopped nasals surface as single, oral stops; e.g., [ikatn]~[ikat] 'fish'. Two optional rules deriving [t] from /t^n/ and /tn/, respectively, are given below in (32):

(32) a. Rule under /t^n/ analysis



b. Rule under /tn/ analysis

[+nasal] → Ø / C___#

In the feature-geometric rule in (32a), the [+nasal] feature of the /t^n/ is optionally delinked (marked on the diagram with the double slash //) from the segment, resulting in the [-nasal] [t]. In the rule in (32b), a [+nasal] segment is deleted following a consonant at the end of the word. Thus, surface [t] is derivable from either /t^n/ or /tn/ and, to the best of our knowledge, no evaluation metric exists which would favor one analysis over the other.

If phonological processes do not distinguish between /t^n/ and /tn/, then we can compare how each analysis fits into the overall phonotactic patterns of the language. Recall from section 2.3 that the general shape of Banyaduq words is (C)V(N)(C)V(C). In this template, consonants appear word-initially, word-medially, and word-finally. However, as discussed in section 2.6, prestopped nasals may only occur word-finally. If we choose the /t^n/ analysis, which treats prestopped nasals as a single C, we must thus add a phonotactic restriction that prestopped nasals may only occupy the final (C) slot in the word structure template. If we choose the /tn/ analysis, which treats prestopped nasals as a CN sequence, we must modify the template to (C)V(N)(C)V(C)(N), which can incorporate final CN sequences. Again, we do not know of any evaluation metric which favors restrictions on phonemes over complicating word templates, or vice-versa.

Other considerations include the size of the inventory and the fact that prestopped nasals are homorganic. The former favors the /tn/ analysis, while the latter favors the /t^n/ analysis. In

[8] Note that we cannot entirely control for environment. The [n] of a [tn] sequence is by definition preceded by an oral stop, while [n]s derived from a single /n/ phoneme will always either be word-initial or preceded by a vowel. This is due to the fact that, as discussed in Section 2.3, word-medial CN sequences do not occur, and so prestopped nasals are the only word-internal stop-nasal sequences. This fact makes it difficult to draw concrete conclusions from duration measurements.

terms of the inventory, the /t^n/ analysis requires adding three more phonemes—/p^m/, /t^n/, and /$k^ŋ$/. If we assume that a smaller inventory is more economical (an idea going back to at least Chomsky & Halle 1968), then the /tn/ analysis allows for a more succinct description of the underlying phoneme inventory, because prestopped nasals are simply sequences of /t/ and /n/ phonemes. However, the homorganicity of these sequences does not automatically fall out from the /tn/ analysis. The /tn/ analysis requires an additional stipulation banning prestopped nasals in which the oral and nasal portions have different places of articulation, such as *[tm] or *[pŋ]. This is not required in the /t^n/ analysis, which, by invoking feature-geometric structure in Figure 5, explains the homorganicity by associating the [-nasal] and [+nasal] features with a single root node associated to a single place feature.

In conclusion, while the phonetic evidence appears to favor a sequence analysis, the phonological evidence does not favor either analysis. We are sympathetic to the view that the analysis of the phonological representation of segments should be based on their phonological patterning, and thus prefer not to make any definitive claim with regard to this issue. However, at least on Riel's assumptions, the evidence seems to favor a sequence analysis.

It is important to note that regardless of whether the correct analysis is ultimately (if ever) decided to be /tn/ or /t^n/, phonemic prestopped nasals present a complication to the phonology of Sangke Banyaduq. On the one hand, /tn/ introduces sequences which do not adhere to the general shape of words in the language, and whose homorganicity must be stipulated. On the other hand, /t^n/ requires introducing additional, complex segments with a restricted distribution into the inventory. Thus, prestopped nasals do not 'fit' well into the overall phonology of the language. As to be discussed in the next section, this fact bears directly on the diachronic situation of Banyaduq prestopped nasals, and offers an explanation for the areally attested diachronic shift from automatic, synchronic prestopping to the total loss of the nasal portion of prestopped nasals.

5 The Diachronic Context of Banyaduq Prestopped Nasals

Blust (1997) suggests that prestopped nasals are an intermediate step in a diachronic transition from word-final plain nasals to oral stops. Sangke Banyaduq provides support for this idea, as its prestopped nasals are optionally pronounced as oral stops. However, Blust provides only an explanation for why the initiation of prestopping might be motivated, not for why the second step, from prestopping to oral stops, might occur. In this section we discuss both the first step from plain to prestopped nasals and the second step, from prestopped nasals to oral stops. We argue that, while there are clear phonetic motivations for the first step, the second step occurs for *phonological* reasons, and that the existence of a stage in which prestopped nasals are no longer allophonic alternants of plain nasals plays a critical role in the transition from prestopped nasal to non-nasal stop.

First, we consider the initial step, the development of prestopping, and propose a phonetic motivation for this change based on Blust's (1997) explanation. Blust notes that, at least within the Austronesian family, prestopped nasals arose in languages in which progressive nasal harmony (what he calls "onset-driven harmony") is predominant. He hypothesizes that prestopped nasals arose in these languages specifically to prevent *regressive* nasal assimilation resulting from coarticulation between a nasal and a preceding oral vowel:

> [I]t seems clear what nasal preplosion [prestopping] does: whereas most final nasals have some nasalizing effect on a preceding vowel, even in languages with [onset-driven] nasal harmony, preploded [prestopped] nasals so to speak "seal off" the preceding vowel from nasalizing influences by adjusting the timing between oral closure and velic opening for a final sequence -VN. It is as if speakers of some languages expect nasal harmony to be unidirectional, and become intolerant of nasalization that spreads in the "wrong" direction. (Blust,

1997, page 161)

In other words, speakers of languages with progressive nasal harmony find the configuration of a final nasal following an oral vowel phonetically unnatural, because it creates the possibility of "bad" *regressive* nasal coarticulation. Because it involves a 'judgment' speakers make about regressive harmony, Blust's (1997) explanation is not strictly compatible with theories of sound change purely based on perceptual and articulatory factors (Blevins 1994, Ohala 1981, 1983). However, it is not difficult to think of a related explanation which does. A transition from an oral vowel to a nasal stop requires coordinating both the lowering of the velum and the articulation of the stop gesture. Mistakes in this coordination would lead to either an oral stop gesture (if the velum is lowered late, after the stop gesture has begun) or bleeding of nasality into the vowel (if the velum is lowered early, before the stop gesture). Speakers of languages with progressive nasal harmony may tend to perceive the former as 'correct' instead of the latter, which contradicts the predominant directionality of nasal harmony. That prestopping only occurs word-finally can be explained by the fact that such misarticulations would be especially perceptible in word-final position, which is known to be prominent (Beckman 1998, Beckman & Edwards 1990).

Blust (1997) rejects an account of prestopping based on listener-based misperception, stating that "it introduces a highly marked segment, one that the listener could hardly have expected as the speaker's intention" (page 162). However, we disagree with the idea that allophonic prestopped nasals are marked, at least for languages with progressive nasal harmony, because in these languages allophonic prestopped nasals are robustly attested. Blust concludes that prestopping developed independently eight times in Austronesian languages in and around Borneo, and proposes that prestopped nasals arose under similar circumstances in the Austroasiatic and Australian language families. We thus propose that prestopped nasals are a phonetically natural resolution to a VN# sequence (where V, as throughout this section, specifically indicates an oral vowel), which for the reasons outlined above, is phonetically unstable in languages with progressive nasal harmony. This sound change, a diachronic version of the NPG given in (18), is summarized in (33):

(33) Diachronic prestopping: Final nasals became prestopped following an oral vowel

While the phonetic motivations for (33) given above are speculative, the conclusion that (33) is a reaction to a phonetically unstable VN# sequence is inescapable if one submits to the theory that all sound change is based in articulatory and perceptual factors (Blevins 1994, Ohala 1981, 1983). While we agree that this theory is likely to be correct with respect to the initiation of prestopping, we shall next show that a phonetically-based approach encounters difficulties with regard to the next step, in which prestopped nasals become oral stops.

Blust notes that there exist a number of languages with word-final oral stops in which historically there was a final plain nasal following an oral vowel—i.e., the environment for prestopping. The following are examples from Kenindjal, a Malayic Dayak language (Hudson 1970) of Borneo, and Urak Lawoi', a Malay dialect of Thailand (Blust 1997) (the other authors use <j> to transcribe a voiced palatal stop; Proto Malayo-Polynesian (PMP) reconstructions are from Blust (1997)):

(34)		Banyaduq	Kenindjal	Urak Lawoi'	PMP	gloss
	a.	[uɟatn]	ujat	hujat	*quzan	'rain'
	b.	[asupm]	(not listed)	asap	*asem	'sour'
	c.	[turakŋ]	tulak	tulak	*tuleqaŋ	'bone'

Blust speculates that these languages must have gone through a 'prestopping' phase, but

have since lost the nasal portion of their prestopped nasals:

(35) Prestopped nasal simplification: Prestopped nasals become oral stops

While Blust provides a phonetic motivation for the diachronic prestopping process in (33), he does not venture an explanation for prestopped nasal simplification (35).[9] From the perspective of phonetic naturalness, (35) poses a problem. If phonetic naturalness is the only motivating factor in sound change, then the occurrence of the prestopped nasal simplification (35) must mean that prestopped nasals are somehow phonetically unstable. However, the discussion motivating the original prestopping generalization in (33) established that prestopped nasals are a phonetically *natural* structure following an oral vowel, at least for languages with progressive nasal harmony: Phonetic pressures are the reason prestopping occurs in the first place. If prestopped nasals are unnatural, then instead of (33), we should expect a direct change from nasals to oral consonants following an oral vowel instead of the attested prestopping. As Blust himself notes, no such change is attested—if it were, then there should be languages with a synchronic alternation between final nasal and oral stops. To the best of our knowledge, this is not attested. Thus, a purely phonetic theory of sound change seems not to be able to explain why both (33) and (35) take place.

We instead propose a *phonological* explanation for (35), based on our synchronic analysis in section 4 of Sangke Banyaduq prestopped nasals as phonemic. Recall from the discussion in section 4.2 that, regardless of whether they are underlyingly sequences or complex segments, Sangke's phonemic prestopped nasals do not fit well into the phonotactic patterns of the language. If prestopped nasals are underlying sequences, /CN/, then they are the only such clusters in the language, requiring the basic (C)V(N)(C)V(C) to be extended to (C)V(N)(C)V(C)(N) in order to accommodate them. If they are single phonemes, /C^N/, then they are the only phonemes which are restricted to word-final position, and they are also the only phonemes with a complex internal structure. Either way, they "stick out" in the overall phonological system of the language.

Under the view that sound change does not only occur for phonetic reasons but that it can act to simplify the phonological system or to preserve phonological structure (Kiparsky 1982, 1995), Sangke Banyaduq prestopped nasals should thus be under phonological pressure to change. Removing the /N/ from the /CN/ sequence would simplify the word template for Sangke Banyaduq, and reducing /C^N/ to /C/ would make for a simpler inventory. Thus, while allophonic prestopped nasals are phonetically natural, *underlying* prestopped nasals are *phonologically* marked, which motivates their synchronic alternation with [C] in Sangke Banyaduq. This interpretation is supported by the fact that, to the best of our knowledge, no such alternation has been reported for languages with allophonic prestopped nasals. Furthermore, the markedness of underlying prestopped nasal phonemes also provides a diachronic explanation for why prestopped nasals make the shift to final oral stops. Why, then, would prestopped nasals simplify to stops and not back to nasals? We can offer a few explanations. One is that the nasal element /N/ is word-final, and word-final elements tend to weaken. Thus, if Sangke prestopped nasals are underlyingly /CN/, then the transition to /C/ is made through deletion of a /N/ segment, which would be an instance of the common diachronic process of word-final consonant loss. If Sangke prestopped nasals are single /C^N/ segments, then the change from /C^N/ to /C/ can be seen as weakening of a complex segment to the less sonorous /C/. One further possibility is that a change from /CN/ or / C^N/ back to /N/ would recreate the phonetically unnatural VN# sequence which prestopping arose to fix in the first place. Under this hypothesis, speakers would prefer the change to /CN/ or / C^N/ to /C/ because it results instead in the phonetically natural VC#.

We have thus provided a phonological explanation for the shift from prestopped nasals to

[9] Thanks to Timothy McKinnon for pointing this out.

final oral stops. Note that because the hypothesized pressures apply to the underlying phonological system, they would not apply to *allophonic* prestopped nasals, because allophonic prestopped nasals derive from underlying, unmarked /N/. This explains why allophonic prestopped nasals are 'stable' enough to be widely attested. Thus, the diachronic picture we paint is two-pronged: phonetic motivations initiate prestopping, but it is phonological pressures that encourage the final transition to oral stops.

One additional possible factor not yet discussed is the voicing of the oral portion of the prestopped nasals. Blust (1997) notes a great deal of variation among languages in the voicing in the oral portion of prestopped nasals; in some languages they are voiced, in some they are voiceless, and in some both are present. Indeed, as mentioned in section 3, Kroeger (2009) observes a geographic continuum in the voicing of the oral gesture in prestopped nasals in the dialects of Biatah (Malaysia). For Sangke Banyaduq, it was seen in section 2.6 that the oral portions of the prestopped nasals are clearly voiceless. How, then, does voicing of the oral portion fit in to the diachronic picture of prestopped nasals, and can it explain the eventual loss of the nasal portion?

As they are diachronically derived from nasal stops, it is natural that in initial stages of prestopping, the oral portion of a prestopped nasal shares its voicing feature with the nasal portion. This can be seen in Jambi Malay, in which all prestopped nasals are voiced (see section 3). There must, then, be some mechanism which, at least in some language varieties, causes devoicing of the oral portion. One clue can be found in Bonggi (Boutin and Howery 1991), in which bilabial and alveolar prestopped nasals are voiced (^{d}n and ^{b}m) but velar prestopped nasals are voiceless ($^{k}ŋ$). Blust (1997) attributes this to the difficulty in maintaining voicing in velar stops (due to their length). It is possible that the voicelessness of the velar stop is then generalized to the prestopped nasals of the other places of articulation. Another possible explanation is a diachronic lengthening of prestopped nasals (perhaps due to word-final lengthening). This would encourage devoicing of the oral portion as length in stops is correlated with voicelessness (Hayes and Steriade 2004, Ohala 1983). This correlation is clear in Sangke Banyaduq, in which the oral portion of prestopped nasals are quite long, as shown by the duration measurements given in section 2.6.1.[10]

This is relevant because voicelessness may factor into the loss of the final nasal, as a voiceless oral portion of a prestopped nasal may induce voicelessness on the following nasal portion, thus making it perceptually weak. However, this cannot be the only factor in the loss of the nasal portion, as voiceless prestopped nasals are frequently attested (e.g. Temahar Banyaduq, and many of the other Land Dayak varieties discussed in Blust (1997) and Rensch et al. (2012)) but, to the best of our knowledge, no attestations of synchronic optional nasal deletion besides that found in Sangke Banyaduq. We thus maintain that it is the *phonemic* status of Sangke Banyaduq prestopped nasals that is the primary motivating factor in the loss of the nasal, and not the voicelessness of their oral gestures (although this may play a secondary role).

One mystery yet remains, however: how can a language develop phonemic prestopped nasals? We offer some possible explanations from Banyaduq. First, we note that the diachronic prestopping rule in (33) is the historical source for Sangke Banyaduq prestopped nasals. In all Sangke Banyaduq forms with prestopping for which we can find a proto-form, the proto-form shows a plain nasal following a vowel with an oral onset. Some examples are below:

(36)

Sangke Banyaduq	proto-form	
a. [ikatn] 'fish'	*hikan id.	(PMP, Blust 1993)
b. [turakŋ] 'bone'	*tuleqaŋ 'bone'	(PMP, Blust 1997)
c. [anãpm] 'sick'	*andam id.	(proto-Bakati, Rensch et. al 2012)

Thus, while section 4 showed that a *synchronic* prestopping process is not active in

[10] Thanks to Abigail Cohn for raising these issues.

Sangke Banyaduq, it is undeniable that there is a *diachronic* relationship between prestopped nasals and historical final plain nasals following an oral vowel. The reason Sangke Banyaduq currently has phonemic prestopped nasals, then, is that an earlier stage of Banyaduq, or one of its predecessor languages, had a synchronic prestopping rule, which has since broken down in Sangke Banyaduq. The question, then, is why did it break down? We can suggest two possible reasons. One potential reason is Banyaduq speakers' increased exposure to and use of Indonesian, a language in which prestopping does not occur, at least in standard varieties. However, exposure to Indonesian would not explain why synchronic prestopping has broken down in Sangke and not in Temahar Banyaduq, as these areas do not differ in their exposure to Indonesian. Another potential reason for the breakdown in Sanke Banyaduq is the loss of word-medial post-stopped nasals. To illustrate this next point, we list some forms from the three Banyaduq varieties discussed in this paper in (37):

(37)		Temahar	Panchi'	Sangke
	a. 'old'	am^{b}a	dama	[amã]
	b. 'day'	an^{d}o	an^{d}o~ano	[anõ]
	c. 'mosquito'	paruŋ^{g}a^{k}ŋ	paruŋak^{ŋ}	[paruŋãkŋ]
	d. 'night'	ŋaru^{p}m	ŋarum	[ŋãrum]
	e. '1sg'	iki^{t}n	ikin	[ikin]

Note that in (37a) through (37c), Temahar Banyaduq has poststopped nasals where Panchi' and Sangke have forms that do not; e.g., in (37a) 'old', Temahar has *am^{b}a* where Panchi' has *dama* and Sangke has [amã]. Also, in (37c) through (37e), we see forms in Temahar that conform to a synchronic prestopping generalization, whereas the forms in Panchi' and Sangke are exceptions to that generalization. In Panchi' and Sangke, (37c) is a prestopped nasal after a nasalized vowel—assuming harmony for Panchi' as well—and plain nasals after oral vowels in (37d) and (37e). What may have happened is that for Panchi' and Sangke Banyaduq, word-medial poststopped nasals changed to plain nasals, which became triggers for nasal harmony. Indeed, Rensch et al. (2012) report a similar development for some dialects of Bidayuh. When this occurred, it created surface exceptions to the prestopping rule, as in (37c) [paruŋãkŋ] 'mosquito'. Perhaps these exceptions led, in the synchronic grammar, to the obfuscation of the rule, and allowed for the other kind of exception, plain nasals following an oral vowel (e.g. (37d) [ŋãrum] 'night'). While we cannot comment further on where these latter exceptions might have come from, the fact remains that what was at one point synchronic prestopping (as it still is in Temahar) has resulted in phonemic prestopped nasals in Sangke Banyaduq (and, apparently, Panchi' as well).

Our discussion of the diachronic shifts from plain nasals to prestopped nasals to oral stops is now complete. We argued, following Blust (with minor modifications), that the first stage of this shift, from plain nasals to prestopped nasals, has clear phonetic motivation in coarticulations stemming from the transition from an oral vowel to a nasal stop. In contrast, the second stage of this shift, from prestopped nasals to final oral stops, is not phonetically motivated, but, rather, is due to phonological pressures to simplify phonemic prestopped nasals. If we are correct, it would be likely that languages like Kenindjal or Urak Lawoi', in which oral stops remain where there were once likely prestopped nasals, went through Sangke-like stages in which the collapse of a synchronic prestopping rule left phonemic prestopped nasals, which then were subject to simplification to an oral stop in order to resolve the underlying marked structure. While this simplification is currently optional in Banyaduq, we hypothesize that in Kenindjal in Urak Lawoi' it became obligatory, thus leaving a single final /C/ where there once was /CN/ (or /C^{N}/).

6 Conclusion

To conclude, this paper has presented an overview of the phonology of Banyaduq, a language which has heretofore been undocumented in the literature. While much of our data is preliminary, two conclusions can be drawn from it that are of general interest: 1) Prestopped nasals in Sangke Banyaduq are *phonemic*, and not allophones of plain nasals; and 2) this phonemic status is critical to understanding the diachronic transition from prestopped nasals to final oral stops. The lesson that Banyaduq teaches us is that prestopped nasals are not a monolithic phenomenon—even among closely related dialects—and that they may play different roles in different phonological systems. As argued in section 5, these distinctions in the phonology have diachronic consequences.

Appendix: Details of duration measurements

<Figure 6>

Measurements for individual tokens are as follows:

Gesture: [tn]

Token	Gloss	[t] Dur. (ms)	[n] Dur. (ms)	[tn] Dur. (ms)
matatn	throw away	161	159	320
agutn	stand up	190	130	320
sadatn	inside	129	100	229
sadatn (2)	inside	154	105	259
bolatn	round	129	153	282
atatn	throw up	127	145	272
ikatn	fish	143	130	274
Average		148	132	279

Gesture: [t]

Initial position (# _)

Form	Gloss	Duration (ms)
tiga	three	122
turah	egg	110
tojo	say	104
tapi	but	112
matatn	throw away	122
tikus	mouse	156
tajapm	sharp	116
tehe	itch	124
Average		120

Medial position (V_V)

Form	Gloss	Duration (ms)
ate	liver	160
ngarati	understand	129
putih	white	139
matoh	throw	113
ato	or	158
lateh	tired	142
kutu	louse	132
mutah	vomit	150
batu	stone	137
ituh	want	139
Average		139.9

Final position (_ #)

Form	Gloss	Duration (ms)
ncagat	to erect	51
nigit	to bite	36
bukit	hill	79
jeket	near	62
sabarat	so-called	99
kilat	lightening	65
kabut	fog	26
jeket (2)	near	62
Average		60

Gesture: [n]

Initial position (# _)

Form	Gloss	Duration (ms)
nujuq	from	106
nangko	steal	104
nagari	village	80
nangkap	fetch	74
nangkap (2)	fetch	91
Average		91

Medial position (V_V)

Form	Gloss	Duration (ms)
nyamani	how much	77
deneq	3SG.POSS.PN	98
anapm	sick	57
anam	six	76
anapm (2)	sick	69
anam (2)	six	66
anapm (3)	sick	62
Average		72

Final position (_ #)

Form	Gloss	Duration (ms)
lapan	eight	164
lapan (2)	eight	122
uman	eat	120
mangkan	give	149
mangkan (2)	give	165
lapan (3)	eight	139
uman (2)	eat	142
Average		143

References

Adelaar, K. Alexander. 1992. “The relevance of Salako for Proto-Malayic and for Old Malay epigraphy.” Bijdragen tot de Taal-, Land-en Volkenkunde 148(3/4):381-408. Leiden: KITLV

Anderson, Steven. 1976. Nasal consonants and the internal structure of segments. *Language* 52(2):326–344.

Anttila, A., 2002. Morphologically conditioned phonological alternations. *Natural Language and Linguistic Theory* 20:1–42.

Beckman, Jill. 1998. *Positional faithfulness.* Doctoral dissertation, University of Massachusetts, Amherst.

Beckman, Mary E. and Jan Edwards. 1990. Lengthenings and shortenings and the nature of prosodic constituency. In *Papers in Laboratory Phonology I: Between the grammar and physics of speech*, ed. by John Kingston & Mary E. Beckman. Cambridge: Cambridge Universeity Press. 151–178.

Blevins, Juliette. 2004. *Evolutionary Phonology: the emergence of sound patterns*. Cambridge, UK: Cambridge University Press.

Blust, Robert. 1993. Central and Central-Eastern Malayo-Polynesian. *Oceanic Linguistics* 32(2):241–293.

Blust, Robert. 1997. Nasals and nasalization in Borneo. *Oceanic Linguistics* 36(1):149–179.

Boersma, Paul and David Weenink. 2013. Praat: doing phonetics by computer [Computer program]. Versions 5.3.01 (retrieved 10 November 2011) and 5.3.41 (retrieved 1 March 2013) from http://www.praat.org/.

Boutin, Michael, and William Howery. 1991. A computational analysis of stop transitions in Bonggi prestopped nasals. In *Proceedings of the International Conference on Current Issues in Computational Linguistics*, pp. 303-316. Penang, Malaysia: Universiti Sains Malaysia.

Chomsky, Noam and Morris Halle. 1968. *The sound pattern of English*. New York, NY: Harper & Row.

Clements, G. N. 1985. The geometry of phonological features. *Phonology Yearbook* 2:225-252.

Court, C. 1970. Nasal harmony and some Indonesian sound laws. In *Pacific linguistic studies in honor of Arthur Capell*, ed. by S.A. Wurm and D.C. Laycock, pp. 203-217. Pacific Linguistics, Series C No. 13. Canberra: The Australian National University.

Durvasula, K. 2009. *Understanding nasality*. PhD thesis, University of Delaware.

François, A. 2010. Phonotactics and the prestopped velar lateral of Hiw – resolving the ambiguity of a complex segment. *Phonology* 27:393–434.

Hayes, Bruce and Donca Steriade. 2004. Introduction: The phonetic basis of phonological markedness. In *Phonetically-Based Phonology*, ed. by Bruce Hayes, Robert Kirchner, and Donca Steriade, pp. 1-33. New York, NY: Cambridge University Press.

Hudson, Alfred. 1970. A note on Selako: Malayic Dayak and Land Dayak languages in Western Borneo. *The Sarawak Museum Journal* 18:301-318.

Ito, Junko and Armin Mester. 2009. Lexical classes in phonology. In *Handbook of Japanese Linguistics,* ed. by Shigeru Miyagawa and Mamoru Saito, pp. 84-106. Oxford: Oxford University Press.

Labov, William. 1994. *Principles of linguistic change. Volume 1: Internal factors.* Malden, MA: Blackwell.

Kiparsky, Paul. 1982. *Explanation in phonology*. Dordrecht, the Netherlands: Foris.

Kiparsky, Paul. 1995. The phonological basis of sound change. In *The Handbook of Phonological Theory*, ed. by John Goldsmith. Pages 640-670. Cambridge, MA: Blackwell.

Kroeger, Paul R. 2009. The dialects of Biatah. In *Languages in Borneo: Diachronic and*

synchronic perspectives, ed. by Peter W. Martin and Peter G. Sercombe, pp 113-144. Phillips, ME: Borneo Research Council, Inc.

Ohala, John. 1981. The listener as a source of sound change. In *Papers from the parasession on language and behavior*, ed. by Carrie S. Masek, Robert A. Hendrick, and Mary Frances Miller, pp. 178–203. Chicago, IL: Chicago Linguistic Society.

Ohala, John. 1983. The origin of sound patterns in vocal tract constraints. In *The production of speech*, ed. by Peter F. MacNeilage, pp. 189–216. New York, NY: Springer.

Orgun, Cemil Orhan. 1996. *Sign-based morphology and phonology, with special attention to Optimality Theory*. Unpublished doctoral dissertation, University of California, Berkeley.

Rensch, Calvin, Caroline Rensch, Jonas Noeb, and Robert Sulis Ridu. 2012. *The Bidayuh Language: Yesterday, today and tomorrow* (revised edition). Austin, TX: SIL International.

Robins, R. H. 1953. The phonology of nasalized verbal forms in Sundanese. *Bulletin of the School of Oriental and African Studies*, 15:138–145.

Sagey, Elizabeth. 1986. *The representation of features and relations in non-linear phonology*. PhD thesis, MIT.

Scott, N. C. 1964. Nasal consonants in Land Dayak (Bukar-Sadong). In *In Honour of Daniel Jones: Papers contributed on his eightieth birthday*, ed. by Abercrombie, D., pp. 432–436. London, UK: Longmans.

Sneddon, James Neil, K. Alexander Adelaar, Dwi N. Djenar, and Michael Ewing. 2010. *Indonesian: A comprehensive grammar*. New York, NY: Routledge.

Yanti, 2010. *A reference grammar of Jambi Malay*. PhD thesis, University of Delaware.

Figure 1: Approximate location of Sangke in West Kalimantan (©2013 Google – Map image ©2013 TeleAtlas, Google, MapIT)

	bilabial	alveolar	Palatal	velar	laryngeal
Stop	p b	t d	c ɟ	k g	ʔ
Fricative		s			h
Nasal	m	n	ɲ	ŋ	
Prestopped nasal	pm	tn		kŋ	
Trill		r			
Lateral		l			
Glide	w		j	w	

Table 1: The Consonant Inventory of Banyaduq

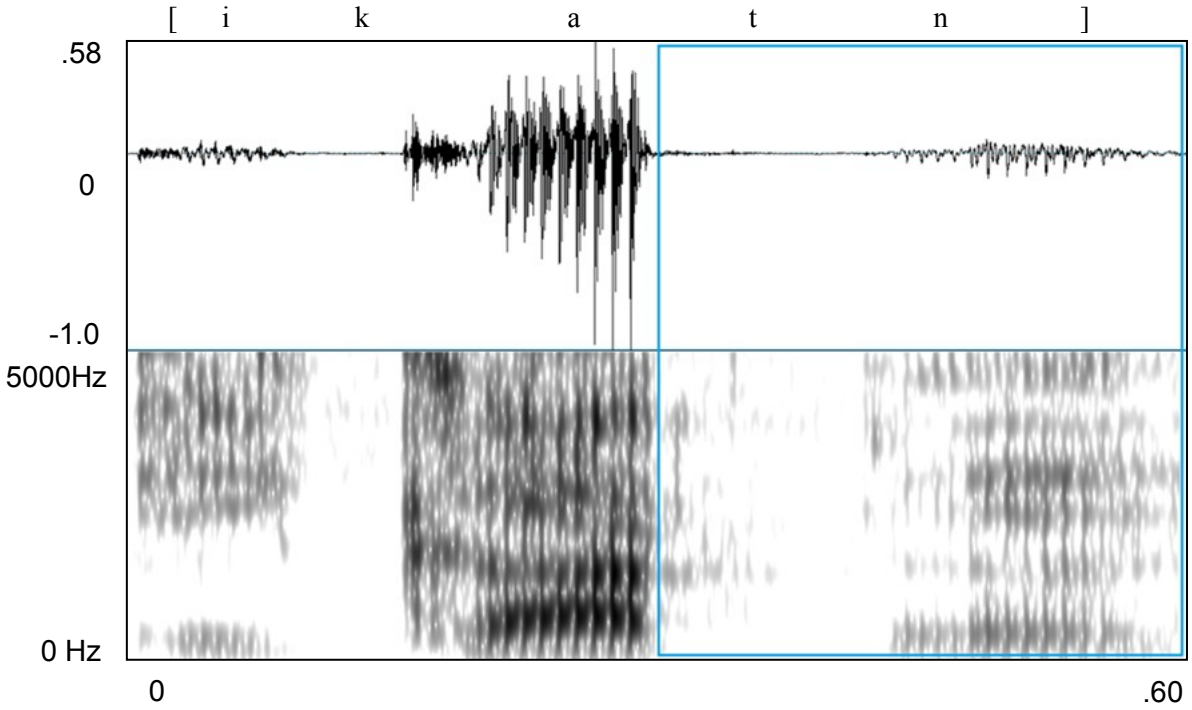


Figure 2: Waveform and spectrogram for [ikatn] ‘fish’

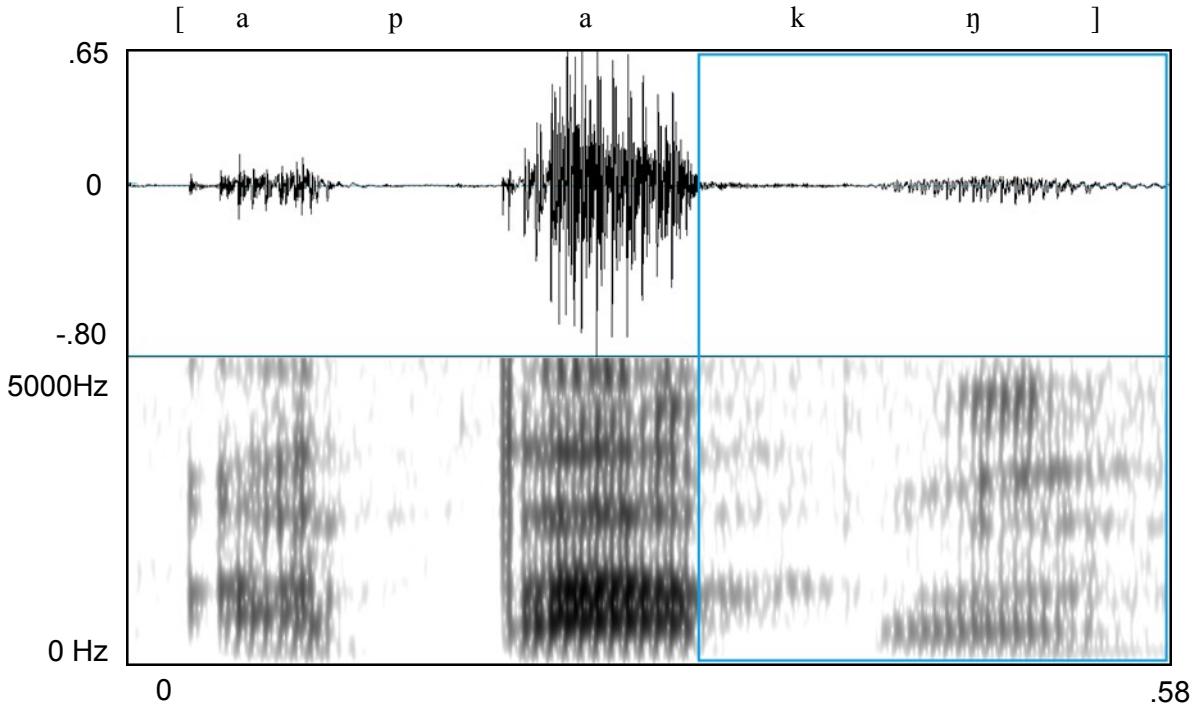


Figure 3: Waveform and spectrogram for [apakŋ] ‘back’

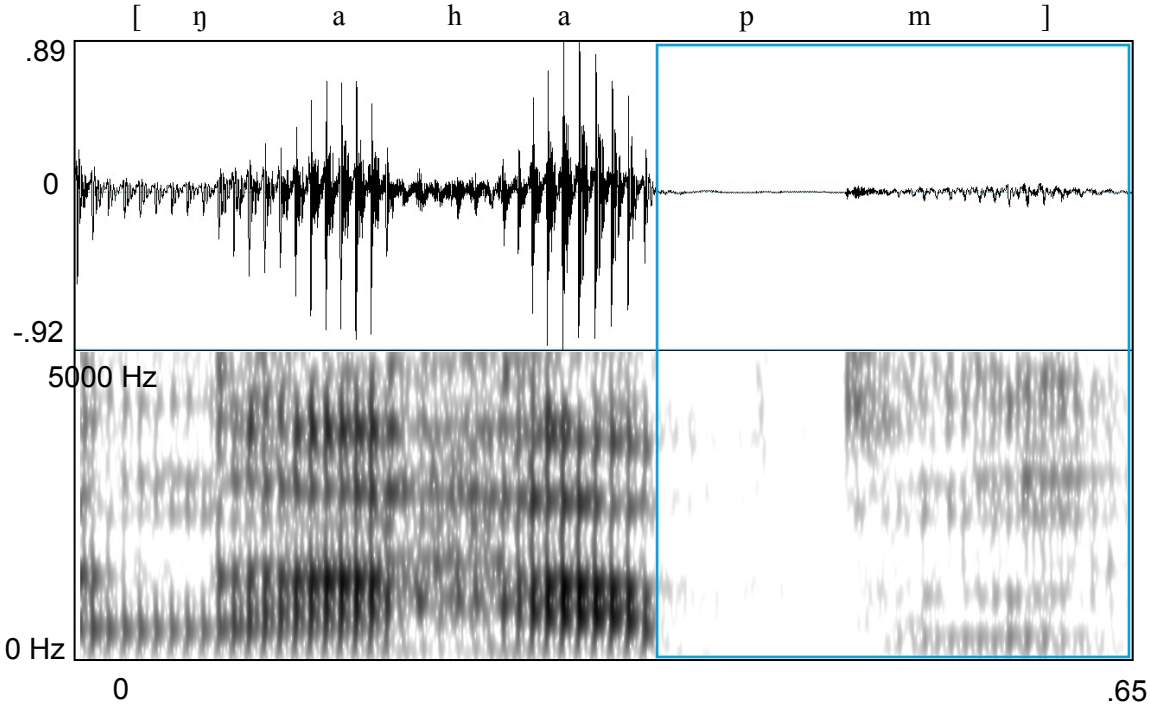


Figure 4: Waveform and spectrogram for [ŋahapm] ‘yawn’

	[#__]	[__#]	[V__V]	[tn#]
[t]:	120 ms	60 ms	140 ms	148 ms
[n]:	91 ms	143 ms	72 ms	132 ms
[tn]:				280 ms

Table 2: Durations of [t] and [n] gestures

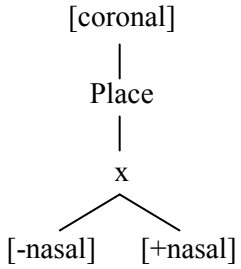


Figure 5: A feature geometry representation of /t^n/

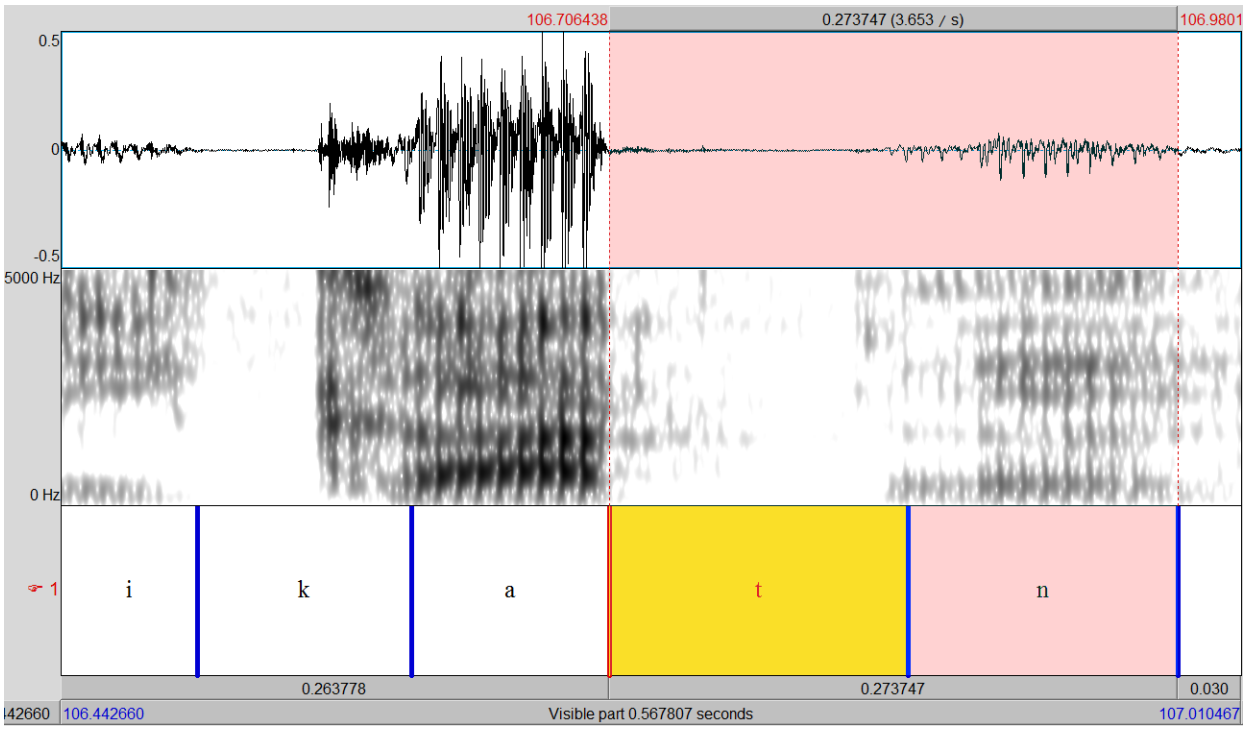


Figure 6: Example of measurement of [tn] in [ikatn] 'fish'. End of the [t] gesture was measured at the first positive zero crossing of the first cycle in the waveform associated with the acoustic energy of the nasal formants. End of the [n] gesture the end of the gesture was marked at the last negative zero crossing of the last cycle in the waveform associated with the acoustic energy of the (first two) nasal formants.