Chapter 1

A tonological rarity: Tone-driven epenthesis in Ghomala'

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This chapter focuses on a little-known tonological rarity: tone-driven vowel epenthesis. In the Cameroonian language Ghomala', an epenthetic vowel is inserted to avoid a rising tone on a syllable closed by an obstruent (e.g. /gə̌p/ → [gə̀pə́] 'hen'), but is never triggered in other tonal contexts (e.g. /bə̂p/ → [bə̂p] 'thorax', *[bə́pə̀]). Morpho-phonological alternations show that when this rising tone is modified, the epenthetic vowel is also lost, illustrating strict co-variation between tone and segment. Unlike most cases of vowel epenthesis in the literature, epenthesis cannot be attributed to segmental or syllabic well-formedness. This paper catalogues all supporting evidence for tone-driven epenthesis the Ghomala', including instrumental analysis of recordings made approximately forty years apart, and develops a representational analysis involving tonal features. Finally, we show that while the motivation for this process is quite common (avoiding a rising tone on a sub-optimal host), the repair itself (i.e. epenthesis) is virtually unprecedented in the tone literature. We discuss three explanations for its rarity: the low functional load of tone, the analytic indeterminacy of epenthesis, and the potential for tone to find a pre-existing host.

1 Introduction

What kind of tones, tone systems, and tonological operations are common in the world's tonal languages and which are rare? While there has been considerable focus on common vs. rare phenomena in non-tonal phonology – e.g. with regard to consonants (Butskhrikidze 2010; Tuttle 2010) or stress/accent (Helmbrecht 2010) within Wohlgemuth & Cysouw (2010)'s volume on *Rara and Rarissima* – less consideration has been given to tone.

Despite its small literature, certain tonological rarities are known at this point. Languages with three to four heights are common enough (e.g. low, mid, and high) but systems with five heights are rare and six virtually unattested (Yip 2002: 20; Odden 2020). Moreover, tonal operations like downstepping are quite common while 'upstep' is attested but much rarer (Snider 1990), and various asymmetries are established with regard to anticipatory vs. regressive tone assimilation (see Hyman 2007 for an extensive survey). Certain tonal patterns are rare and contentious enough to generate a literature unto themselves, e.g. the famous Xiamen/Southern Min tone circle in its tone sandhi system (Dong 1960; Chen 2000: 42ff. Zhang et al. 2006; *inter alia*).

For this chapter, our specific focus is on rarities in tone/segment interaction. Some interactions are well-known and quite common such as consonant depression from voiced consonants, while others very rare such as tone height/type dependent on vowel height (Jiang-King 1999; Yip 2002: 31). In general, most interactions are from segments to tone, and rarely from tone to segments (Wee 2019: 208). What we show is an even rarer case: the insertion of a vowel itself in order to host a tone, i.e. 'tone-driven epenthesis'.

While rare amongst tone languages, within the intonation literature a comparable process of intonation-driven epenthesis is more common (albeit still rare). Its appearance can be situated within larger discussion of 'text-tune' relationships in intonation. In cases where there is a mismatch between the segmental structure (the 'text') and the intonational melody (the 'tune'), normally it is the melody which accommodates (e.g. through truncation). A growing literature shows evidence for the opposite as well: segmental structure changing to accommodate the intonation (Roettger 2017; Grice et al. 2018; Roettger & Grice 2019).

To illustrate, consider a recent study of Tunisian Arabic intonation (Hellmuth 2022). Yes-no questions are commonly realized with a rise-fall intonational complex (i.e. L*+H H-L%) at the right edge of an intonational phrase. When this intonational complex appears, it often co-occurs with an epenthetic vowel to which part of this complex docks. An example of phrase-final [ə] epenthesis is in (1).

(1) nkemmil t$^{\text{ʕ}}$uːl → [nkemmil t$^{\text{ʕ}}$uːləː]
I-continue straight.ahead
'Should I go straight ahead?' (Hellmuth 2022)

Epenthesis only appears in the context of this complex rise-fall contour, and even then only half the time. Importantly, it *never* appears when there is only a simple rise or simple fall, even in the context of a yes/no question. Tunisian Arabic thus shows clear co-variation between a final vowel and a complex pitch event.

If epenthesis is rare in intonation, it is practically unheard of for tonal languages where pitch is used to express lexical and grammatical meanings. Its rarity has been addressed previously (Blumenfeld 2006; Gleim 2019; Rolle & Merrill to appear), but overt acknowledgments remain sparse. Although rare, we argue that tone-driven epenthesis is exactly what is found in the tonal language Ghomala' based on a variety of arguments from both root structure and morphophonological alternations. Unifying tone-driven and intonation-driven epenthesis is that both are attributable to a functional pressure to cultivate segmental environments best suited for realizing pitch targets.

This paper is organized as follows. Section 2 provides essential background information on the Ghomala' language, Section 3 presents the evidence for tone-driven epenthesis, and Section 4 presents an unforeseen consequence of our analysis, namely support for tonal features. Following these, Section 5 situates the rarity of tone-driven epenthesis in a typological perspective, and Section 6 provides three possible explanation for its rarity. Section 7 concludes this chapter.

2 Background on Ghomala'

2.1 The language setting

Ghomala' (pronounced [ɣɔ̀málâʔ], – ISO 639-3: bbj) is a Bamileke language of the Grassfields family spoken in Western Cameroon, part of the larger Bantoid subgroup within the Niger-Congo phylum. In this paper, we examine data from the Bandjoun and Baham varieties, both of which are closely-related varieties of the Central dialect of Ghomala' (Domche-Teko & Hatfield 1991: 3; Mba 1997), as opposed to the North and South dialects. In fact, Ghomala' has been called simply Bandjoun in the literature (a.k.a. Banjun or simply Jo), so-named because it is the main Ghomala-speaking chefferie (Mba 1997: 77).

Ghomala' has at least 350,000 speakers (Kamdem 2020: 2, citing Simons & Fennig 2018's edition of Ethnologue). Its speaker population is likely much higher than that, e.g. other religious organizations like the Joshua Project place it at 1.145 million speakers[1]. Ghomala' is relatively healthy, widely spoken as the community language (Domche-Teko & Hatfield 1991), with most of the children of the Ghomala community being at least Ghomala'-French bilingual today (Kamdem 2020: 3, fn4). Ghomala' (especially Bandjoun, the *de facto* standard) is often used in print, has been taught in local schools and universities, is used regularly on local radio, and there have been various literacy and standardisation efforts un-

[1]See https://joshuaproject.net/languages/bbj.

derway for several decades now (Domche-Teko & Hatfield 1991: 8). See Domche-Teko & Hatfield (as well as Bomda 2005: 45ff.) for a comprehensive timeline of the earliest descriptions of Ghomala', dating back to the colonial period.

Data in this chapter come primarily from grammatical description in Nissim (1972; 1981) and recordings made around the time of these publications, as well as a modern dictionary of Ghomala' (Eichholzer 2010). The data points which are relevant to tone-driven epenthesis are confirmed by other publications on Ghomala' (Ntagne & Sop 1975; Piron 1997), as well as YouTube recordings made by Ghomala' language advocates (in particular in Section 3.3). Since these latter recordings are made some forty years after Nissim, they speak to the stability of these Ghomala' patterns. As will be shown, however, there is some variation in the epenthesis patterns and such complicating data are explained when they come up (provided with its source). We emphasize that this variation does not detract from the principle claim of this paper, i.e. that Ghomala' exhibits tone-driven epenthesis.

2.2 Phonological profile

Ghomala' has both a rich set of consonantal contrasts and vocalic contrasts (Nissim 1981; Bomda 2005), summarized in Table 1. Among consonants, there are five places of articulation, with various stops, affricates, fricatives, nasals, and approximants. The consonants in parentheses may be derived from the other consonants at an abstract level of analysis Nissim (1981: 121–130), but for practical purposes they are separate phones and transcribed as such. Among vowels, there are four heights and three degrees of backness.

Table 1: Segment inventory of Ghomala'

LABIAL	DENTAL	PALATAL	VELAR	GLOT.	FRONT	CENTRAL	BACK
p b	t d		k g	ʔ	i	ʉ	u
pf bv	ts dz	c j			e	ə	o
f (v)	s	(š) (ž)	(ɣ)	h	ɛ	ɑ	ɔ
m	n		ŋ			a	
	(l)	y	ʉ̂				
		ẅ	w				

Ghomala' transcriptions follow the IPA except for c=[tʃ] and j=[dʒ] (although Nissim describes them as both palatal and affricated), š=[ʃ] and ž=[ʒ], y=[j],

ẅ=[ɥ], ʉ̈=[ʉɥ], ʉ=[ʉ]~[ɯ], and ɑ=[ɐ]; see Nissim (1981: 45-71) for their phonetic details. Other more marginal phones include [z], aspirated stops [tʰ dʰ pʰ bʰ kʰ], and pre-nasalized stops, as well as various consonant + glide sequences.

Two final phonological details are relevant to our later discussion. First, of the consonants only /m ŋ p k ʔ/ may appear in coda position. Second, canonically both lexical morphemes (i.e. roots) and functional morphemes are monosyllabic. This fact is important in our analysis of final epenthetic vowels, which expand a monosyllabic form into a disyllabic one.

2.3 Morphological/syntactic profile

Nouns belong to one of six noun classes (three singular and three plural). Owing in part to the monosyllabic preference on roots, noun classification is often only reflected in noun phrase concord rather than through marking on the noun itself (e.g. the demonstrative 'this' has forms yaŋ, tsɔ, pɔ, and mɔ depending on the class of the noun).

Canonical word order is [SUBJECT PARTICLE(S) VERB OBJECT (OTHER)] (where 'other' includes structures like adverbs or prepositional phrases). A typical sentence is in (2). We will explain the tone marks shortly.

(2) [gā ê də má ă gɔ̄ m̄ lɔ́ʔtà]
gā ê N-lə má ă N-ɣɔ̄ m̄ lɔ́ʔtà
1S H_PST INFL-take mother my INFL-go to hospital
'I took my mother and went to the hospital (today)' (Kamdem 2020: 100)

Verbal affixation is highly constrained, and inflection is primarily marked via a series of pre-verbal particles (Kamdem 2020: 97–98), such as ê H_PST (hodiernal past) in (2). Several inflectional patterns consist simply of a general inflectional morpheme N- (INFL) which is realized either as pre-nasalization or a consonantal change (also seen in 2). Suffixation is restricted to a small set of multi-functional derivational markers indicating meanings such as repetition of action, plurality on arguments, valency changes, *inter alia* (Mba 1997). These facts will become important as we develop our arguments in Section 3.

2.4 Tone system

With regard to tone, at an basic level of analysis Ghomala' makes a central distinction between high (H) and low tone (L). In reality, there are numerous surface tone heights and several contour tones as well. To illustrate the tone system,

consider the open monosyllabic roots in Table 2. Here, a basic six-way contrast can be discerned by comparing pronunciations in isolation to pronunciations in object position.

This table shows there are two types of high tones. One is consistently realized as high, and transcribed simply as H (row a). The other is realized high in isolation but in context surfaces as a downstepped high, transcribed ˡH (b). Likewise, there are two types of low tones. One is realized as a level low tone which does not fall to the lowest part of the pitch range (c), transcribed as L˚ with a degree symbol (following Africanist conventions – e.g. Bird 1999). The other low is one which *does* fall to the lowest part of the pitch range as expected (d), transcribed simply L. Finally there are two contours, one being a LH tone which is realized rising in isolation but may also be realized as a downstepped high in certain contexts (e), the other being a HL tone consistently realized as a falling tone. Note that the tone letters provided are schematic approximations of the relevant contrast and should not be interpreted as phonetic extrapolations *per se*.

Table 2: Tone contrasts on open roots (Nissim 1981: 150, 153)

	Tone	Isolation			Context		
a.	H	**fɑ́**	⌝	‘parent’	ǒ ˡyɔ́ **fɑ́**	⌝	‘you saw the parent’
b.	ˡH	**dhɔ́**	⌝	‘spouse’	ǒ ˡyɔ́ ˡ**dhɔ́**	⊣	‘you saw the spouse’
c.	L˚	**tsə̀˚**	⌟	‘cola nut’	ǒ ˡyɔ́ **tsə̀˚**	⌟	‘you saw the cola nut’
d.	L	**tà**	⌟	‘pot’	ǒ ˡyɔ́ **tà**	⌟	‘you saw the pot’
e.	LH	**bvʉ̌**	⌿	‘dog’	ǒ ˡyɔ́ ˡ**bvʉ́**	⊣	‘you saw the dog’
f.	HL	**bʉ̀ə̂**	⍀	‘madman’	ǒ ˡyɔ́ **bʉ̀ə̂**	⍀	‘you saw the madman’

Regarding the downstepped-low tone (row c), several sources on Ghomala’ transcribe this as a mid tone (Bomda 2005; Bessala & Moguo 2017; Kamdem 2020; Moguo 2021), while Nissim (1981: 72) refers to this tone value as *le ton central* which is typographically not marked by any diacritic. Nissim explicitly contrasts this tone against a mid tone (*ton moyen*) found in related languages but not Ghomala’. In this work, we shall exclusively use the L˚convention established. At a descriptive level, they all can be understood simply as notational variants and are transcriptionally equivalent. We demonstrate this in Table 3; this additionally shows uniformity across all sources in marking high and low tone.

Table 3: Transcriptional equivalence of L° and M across sources

	Tone	This work	Nissim 1981		Bomda 2005		Meaning
a.	H	só	só	(p. 72)	só	(p. 56)	'friend'
b.	L°	bàp°	bap	(p. 50)	bāp	(p. 53)	'meat'
c.	L	fò	fò	(p. 50)	fò	(p. 51)	'chief'

3 Tone-driven epenthesis

On this six-way tone contrast, the most important for this chapter is the rising tone (LH, row e from Table 2). Building on the original description of Nissim (1981), we defend the thesis that this tonal contrast conditions tone-driven epenthesis, defined as the phonological insertion of a vowel in order to realize a pitch target. Specifically, words like /gɔ̌p/ 'chicken' are realized as [gɔ̀pə́] where the final [ə] is epenthetic. We turn to these matters in this section.

3.1 Segment-tone co-variation

The first thing to establish is the co-variation between a final vowel segment and rising tone. In Table 2 we showed the contrastive tone patterns on monosyllabic open roots. These same patterns are found with syllables closed with a sonorant coda /m ŋ/ (these being the only sonorants allowed in this position), demonstrated in Table 4. Note that the distinction between H and downstepped ꜜH is not always apparent (e.g. within dictionary entries) since they are pronounced identically in isolation. We therefore do not make this distinction in this table, nor in the tables which follow. Our analysis is not affected because of this.

Table 4: Tones on syllables with sonorant codas

Tone	Example		Meaning	Source
H	/kɔ́m/	[kɔ́m]	'crab'	(Nissim 1981: 216)
L°	/lə̀m°/	[lə̀m°]	'condiment'	(Nissim 1981: 72)
L	/lə̀m/	[lə̀m]	'dry season'	(Nissim 1981: 72)
HL	/fâm/	[fâm]	'plantation'	(Eichholzer 2010: 16; from Eng. *farm*)
LH	/bə̌m/	[bə̌m]	'destiny'	(Nissim 1981: 74)

In contrast, let us now consider syllables closed by an obstruent coda, which

in Ghomala' can only be /p k ʔ/. Data are in Table 5. As seen in the last row, a LH-toned syllable may be realized either with a rising tone (faithful to the underlying representation) or with a vowel epenthesized to the root. In this latter variant, the L portion falls on the lexical vowel and the H portion on the epenthetic vowel. Importantly, epenthesis is never found in the other tonal contexts.

Table 5: Tones on syllables with obstruent codas

Tone	Example		Meaning	Source
H	/káp/	[káp]	'pipe'	(Eichholzer 2010: 23)
L°	/bàp°/	[bàp°]	'animal'	(Eichholzer 2010: 3)
L	/pàp/	[pàp]	'wing'	(Nissim 1981: 218)
HL	/lâp/	[lâp]	'elegance'	(Eichholzer 2010: 31)
LH	/lăp/	[lăp]~[làpə́]	'pool of water'	(Eichholzer 2010: 31)

This variation is found throughout the Ghomala' literature for LH words in isolation, often with the same word transcribed in both ways. For example, what (Nissim 1981: 198) transcribes as vɔ̀pə́ 'dust' (French *poussière*) Moguo (2021: 141) transcribes as vɔ̆p. Forms with and without the final vowel are thus interchangeable, and there is no contrast between such forms.

In the most comprehensive description to date, Nissim (1981) is explicit in treating this final vowel as epenthesis, stating that its only function is to support the tone complex (pp. 65, 90). All cases of obstruent codas show the epenthetic vowel variant if and *only* if it has rising tone. The example set in Table 6 demonstrates epenthesis with all three possible codas /p k ʔ/. With coda /p/ and /k/, an epenthetic [ə] is inserted to host the H portion of the rising tone while with /ʔ/ it is either [ə] or a copy of the root vowel. As stated, there is no comparable variation among the other tonal contrasts, i.e. with forms from Table 5 there exists no variation for /pàp/ 'wing' between [pàp] and *[pàpə̀] or for /lâp/ 'elegance' between [lâp] and *[lápə̀], *et cetera*. This distribution demonstrates that epenthesis of the final vowel is not triggered by a markedness constraint against final obstruent codas. If this were the case, we would expect epenthesis to be conditioned primarily by segmental context rather than tonal context.

Spectrograms of Ghomala' words and phrases pronounced in isolation confirm the presence or absence of a final vowel. These recordings were provided by Larry Hyman. They were originally recorded under the direction of Gabriel M. Nissim in Cameroon, collected around the time of his writing Nissim (1981). The recording is of a single speaker of Ghomala' saying individual words in isolation

Table 6: Epenthesis when rising tone appears with obstruent coda

	Example		Meaning	Source
a.	/gɔ̌p/	[gɔ̀pə́]	'hen'	(Nissim 1981: 63)
	/cǎp/	[càpə́]	'corn cake'	(Nissim 1981: 74)
b.	/fɔ̌k/	[fɔ̀χə́][a]	'cold'	(Nissim 1981: 65)
	/sǎk/	[sàχə́]	'wall'	(Nissim 1981: 65)
c.	/gwɔ̌ʔ/	[gwɔ̀ʔə́]	'termite'	(Nissim 1981: 146)
	/lǎʔ/	[làʔá]	'village'	(Nissim 1981: 74)
	/pǔʔ/	[pùʔú]	'package'	(Nissim 1981: 146)
	/gŭʔ/	[gùʔú]	'strength'	(Nissim 1981: 90)

[a]There is an independent process of frication (and backing) which affects /k/ between vowels.

and within associative (i.e. genitive) noun phrases containing two nouns [N_1 N_2], in either N_1 or N_2 position.

Figures 1 and 2 show roots with LH tones (the pitch is the red line, and pitch range is marked at the right). Figure 1 shows a LH tone on an open syllable with a clear and steady rise, while Figure 2 shows a LH tone with a coda /p/. It is clear from the spectrogram that in this latter context a full vowel [ə] appears after the final consonant and bears the H portion of the tone. Compare this to Figure 3 which shows a level low tone (L°) on a syllable closed by the obstruent /p/. Unlike Figure 2, here the /p/ is unreleased and no vowel follows it. Parallel facts hold in the recordings involving coda /k/ and /ʔ/, not shown.

Moreover, unlike with coda obstruents, coda nasals /m ŋ/ do not show a variant with an epenthetic vowel. A spectrogram confirms the lack of a final vowel in such LH contexts, shown in Figure 4. It is clear that the rising portion of the pitch is realized on [ŋ] itself. These patterns show that sonorant codas behave analogous to open syllables in permitting a rising tone realization without recourse to epenthesis.

A restriction on rising tones with coda obstruents but not coda sonorants is exactly the type of constraint which is predicted based on previous typological surveys of contour tones (Zhang 2013). As we stated in the introduction, what is tonologically rare is not the dispreference for rising tones with obstruent codas, but rather it is the repair itself (i.e. the epenthesis operation) which is rare. We return to this matter in Section 5 below.

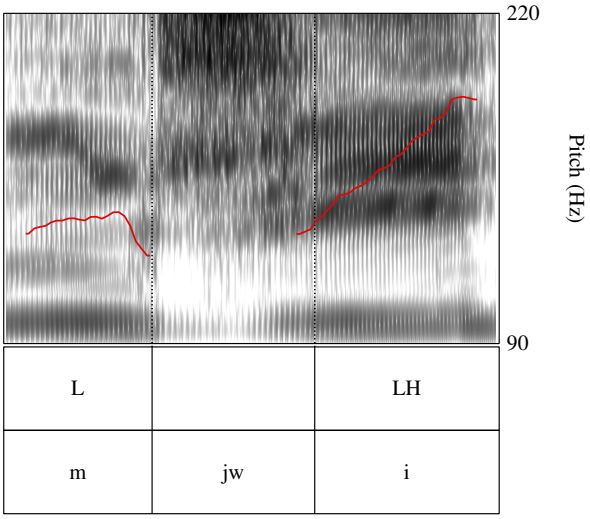

Figure 1: LH tone on open syllable – /mjwǐ/ [mjwǐ] ‘woman’

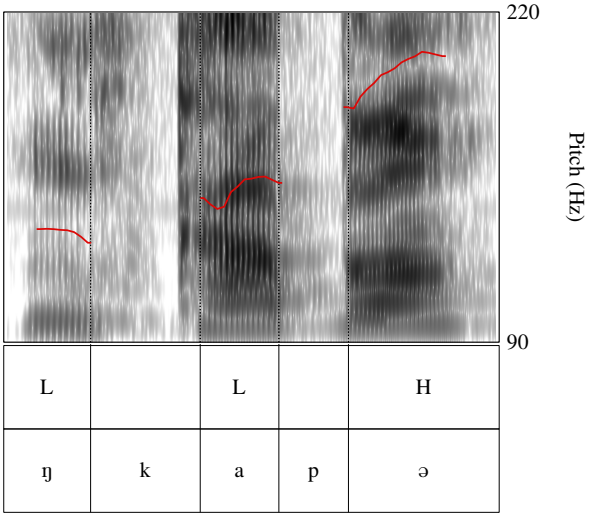

Figure 2: LH tone on syllable with coda /p/ – /ŋkǎp/ [ŋkàpɔ́] ‘money’

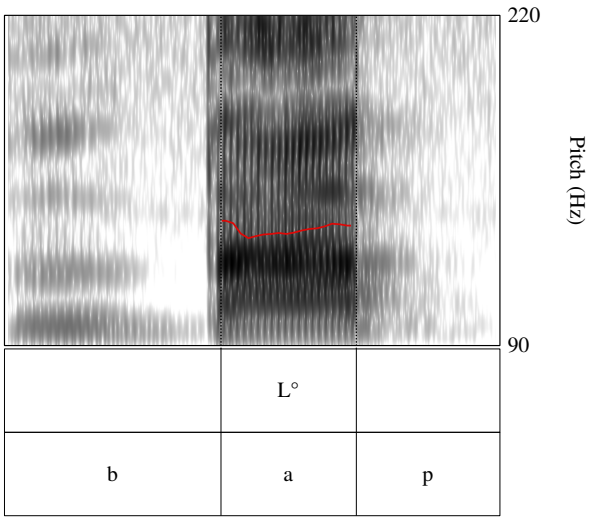

Figure 3: L° tone on syllable with coda /p/ – bàp° 'animal'

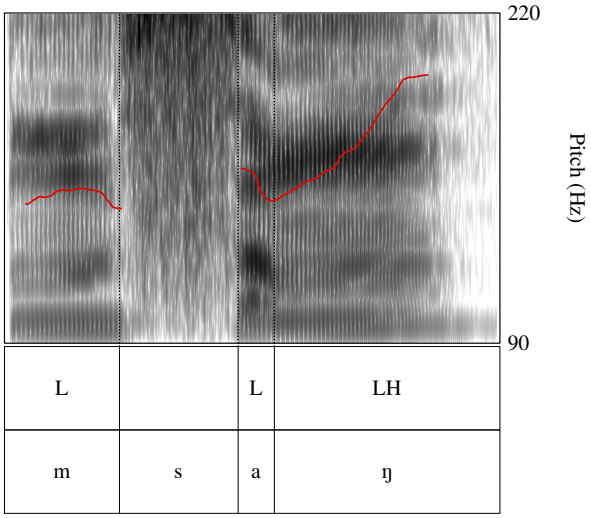

Figure 4: LH tone with sonorant coda – /msǎŋ/ [msàǹ] 'birds' (PL)

3.2 Against a deletion alternative

We now defend the contention that this is indeed epenthesis as opposed to an alternative involving deletion of an underlying vowel, i.e. this is /cvc/ ⟶ [cvcə] rather than /cvcə/ ⟶ [cvc].

The first argument involves root phonotactics generally. As stated, the vast majority of roots in the language are monosyllabic (e.g. CV/CVC shapes). The major exception to this generalization are exactly those [cv̀cá] forms detailed above. If we treat these at an abstract level as /cv̆c/ which only become disyllabic later in the derivation, then this unifies the possible shape of roots.

Multisyllabic words not attributable to this epenthetic operation are nearly always decomposable into multiple morphemes. These include compounds of some type (e.g. nɔ̀m-gẅì 'panther', more literally 'animal-panther') or derived forms with a derivational affix (e.g. suffixes /-nyə/ and /-tə/ or the prefix /kə̀-/). Examples of the latter are in (3); we return to such suffixes shortly, in Section 3.3.

(3) Disyllabic stems as multi-morphemic (Nissim 1981: 91-92)
   a. kùŋ 'love' ⟶ kùŋ-nyə̀ 'love each other'
   b. pà 'carry on back' ⟶ pà-tə̀ 'carry carefully' (e.g. of an baby)
   c. kə̀-ló? 'badly put together'

Such disyllabic sequences with final [ə] are quite common, demonstrating that there is no general phonological constraint against final [ə] in Ghomala'.

Any remaining forms which cannot be decomposed constitute a marginal percentage of the lexicon, including forms such as /bìyɛ́/ 'peanut', /gə̀fə̀/ 'corn', /kə́pák/ 'lizard', among others. To this we can add loanwords from English and French found in Eichholzer (2010), e.g. /bə̀lə̀ŋ/ from English 'blanket' or /bàtô/ 'boat' from French *bateau*.

The second argument for an analysis as epenthesis (as opposed to final [ə] deletion) involves a restriction on co-occurring vowels. Recall the vowel inventory /i e ɛ ʉ ə ɑ a u o ɔ/ of Ghomala' established in Table 1 (where ɑ is IPA [ɐ]). Of these, not all are permitted in closed syllables. Before coda /p/ and /k/ only the low vowels /ɔ/ and /a/ are allowed (a few loanwords escape this generalization, e.g. /hɛ̂p/ 'help' – Eichholzer 2010: 21). The data shown from Table 6 above were representative of this restriction.

It is clear diachronically that multiple vowel categories have merged in these closed syllable contexts. Comparing Ghomala' data to Proto-Eastern Grassfields reconstructions (Elias et al. 1984), we see widespread neutralization before coda obstruents, such as before *b and *p codas, shown in Table 7. Such data show

that each of these distinct vowels in the Proto-Eastern Grassfields (Proto-EG) corresponds to a Ghomala' form with /ɔ/.

Table 7: Historical merger of vowel qualities before obstruent codas

Proto-EG (Elias et al. 1984)[a]				Ghomala'		Source
*-gʉ́ɓ	*chicken	(p. 52)	>	gɔ̌p~gɔ̀pə́	'hen'	(Eichholzer 2010: 18)
*-kíɓ	*fingernail	(p. 90)	>	ŋkɔ̀pə́	'nail'	(Nissim 1981: 198)
*-bóp-	*fear	(p. 90)	>	pwɔ́k	'afraid'	(Nissim 1972: 43)
*-béɓ	*he-goat	(p. 59)	>	pɔ̌p~pɔ̀pə́	'goat'	(Eichholzer 2010: 45)

[a]The tone marks above the consonants in these proto-forms are reconstructed floating tones.

Importantly, this constraint holds both for surface [cvp]/[cvk] forms (e.g. bàp° 'animal'), as well as surface [cvpə]/[cvkə] forms (e.g. gàpə́ 'antelope'). If the latter forms were underlyingly /cvcə/ (i.e. an analysis without epenthesis), then we would expect a wider range of vowels to be permitted since the environment for the first vowel would not be a closed syllable. In other words, we might expect non-existent roots such as */bùpə́/ and */gɛ̀kə́/). That this is not the case speaks to such sequences being treated as /cvc/ at some level of grammar.

3.3 Morpho-phonological alternations

Further strengthening our analysis as epenthesis, Ghomala' shows frequent and general morpho-phonological alternations between surface forms with and without a final [ə]. Here, the o-variation between tone and [ə] mirrors that of root phonotactics, demonstrating that it is an active part of Ghomala' grammar.

Let us first consider data from derivation which show the parity between surface rises and forms with final [ə] in the realization of LH tone. In a type of deverbal nominalization, the lexical tone of root is overwritten with LH tone (Nissim 1981: 288-289), shown in Table 8. With open syllables (a) or coda sonorants (b), the pattern surfaces with a rising tone without complication. In contrast, the LH pattern induces an epenthetic [ə] with coda obstruents (c), mirroring the pattern in underived roots.

Next consider [ə] alternations in complex noun phrases. Associative constructions involve two nouns where the first noun is the head and the second noun the modifier, used for structures like possession and compounds. Examples are in Table 9 involving various H- and L-toned roots in N_1 position and the noun /bàp°/

Table 8: [ə] alternations in V⟶N derivation (Nissim 1981: 288-289)

a.	tʉɔ̀	'be strong'	⟶	tʉɔ̌	'iron'
	sú	'(to) weed'	⟶	sǔ	'hoe'
b.	tùŋ	'dig inside'	⟶	ntǔŋ	'throat'
	tɔ́m	'push'	⟶	tɔ̌m	'fruit'
c.	tsʉ̀ʔ	'twist'	⟶	dzʉ̀ʔʉ́	'liana (vine)'
	fɔ́k	'blow (cold)'	⟶	fɔ̀kə́	'cold'

'animal' in modifier position (N_2). As is ubiquitous in related Bantu/Bantoid languages, Ghomala' has an elaborate noun class system which is reflected morphologically in the shape of morphemes that are in agreement with the head noun. One way this manifests is through the grammatical tone in the associative construction. In Table 9, nouns of class 1 condition a floating low grammatical tone (Ⓛ) which links the two nouns (following Yip 2002, floating tones unassociated in the input are circled). In contrast, other classes (e.g. class 3) condition a floating high tone (Ⓗ). These grammatical tones result in various tonal changes, e.g. in (a) /mú/ becomes falling [mû] while in (b) the second low tone becomes downstepped.[2]

Table 9: Class-dependent grammatical tone (Nissim 1981: 249-250)

a. CL 1	/mú	Ⓛ	bàp°/	⟶	[mû bàp°]	'the child of the animal'
	/gì	Ⓛ	bàp°/	⟶	[gì bàp°]	'the voice of the animal'
b. CL 3	/thə́	Ⓗ	bàp°/	⟶	[thə́ bàp°]	'the head of the animal'
	/kwə̀	Ⓗ	bàp°/	⟶	[kwə̀ ↓bàp°]	'the foot of the animal'

Nissim (1981) provides extensive paradigms detailing these tonal changes, both within the associative construction as well as in other complex noun phrases (e.g. with possessive pronouns, demonstratives, indefinites, *et cetera*). We schematize the tone patterns of these paradigms in Tables 10 and 11. The underlying tone of the first noun (the head noun, N_1) is at the far left and that of the second noun (the

[2] In light of this downstep pattern, it may be more accurate to analyze the associative marker as a floating register feature ⓗ rather than a floating tone Ⓗ. This anticipates our discussion of tonal features in Section 4 below, so we shall not expand on this point here. An analysis of this grammatical marker as ⓗ or Ⓗ is not critical to our overall argument and we keep Ⓗ for the sake of simplicity.

modifier, N_2) is in the top row. Table 10 shows the tone paradigm for association constructions involving a class 1 head noun. Such environments condition the floating Ⓛ grammatical tone. Here the tone of N_2 remains intact while the tone of N_1 is altered. In contrast, Table 11 summarizes those constructions involving a non-class 1 head noun (e.g. class 3 in Table 9). These condition the Ⓗ grammatical tone, with the tones of N_2 being modified while those of N_1 remaining largely unmodified.

Table 10: Associative tone paradigm with class 1 head noun

N_1 / N_2	H	ꜜH	L°	L	**LH**
H	[HL H]	[HL H]	[HL L°]	[HL L]	**[HL LH]**
L°	[HL H]	[HL H]	[HL L°]	[HL L]	**[HL LH]**
L	[L H]	[L H]	[L L°]	[L L]	**[L LH]**
LH	[HL H]	[HL H]	[HL L°]	[HL L]	**[HL LH]**

Table 11: Associative tone paradigm with non-class 1 head noun

N_1 / N_2	H	ꜜH	L°	L	**LH**
H	[H H]	[H ꜜH]	[H L°]	[H L]	**[H ꜜH]**
L°	[L H]	[L H]	[L ꜜL°]	[L ꜜL]	**[L H]**
L	[L H]	[L H]	[L ꜜL°]	[L ꜜL]	**[L H]**
LH	[LH H]	[LH ꜜH]	[LH L°]	[LH L]	**[LH ꜜH]**

The relevant portions for our examination of tone-driven epenthesis are the rightmost columns in both of these tables (in bold). For nouns in N_2, those with an underlying LH pattern show two realizations. If a class 1 noun is in N_1 position (Table 10), N_2 surfaces as a rising tone. In contrast, if the noun of N_1 is of any other class (Table 11), N_2 surfaces as a downstepped high tone.

This [LH]~[ꜜH] alternation surfaces without complication with open syllables and with coda sonorants, e.g. /bvə̌/ [bvə̌] ~ [ꜜbvə́] in (4).

(4) [LH]~[ꜜH] morpho-phonological alternation in N_2

a. /mú Ⓛ bvə̌/ ⟶ [mû bvə̌] 'the child of the dog' (Nissim 1981: 264)

b. /thɔ́ Ⓗ bvə̌/ ⟶ [thɔ́ ꜜbvə́] 'the head of the dog' (Nissim 1981: 153)

Importantly, N_2 nouns show the expected co-variation between tonal pattern and final vowel when there is a coda obstruent. Consider the noun /gɔ̌p/ 'hen' which in isolation is pronounced [gɔ̀pə́]. Nissim (1981: 157-158, 250-252) provides paradigms consolidated in Table 12 which show that in the rising tone contexts this surfaces as [gɔ̀pə́] with a final vowel, but in the downstepped contexts it surfaces as [ꜜgɔ́p] without the final schwa.

Table 12: Co-variation between tone alternations and final [ə] in noun phrases (Nissim 1981: 157-158, 250-252)

a.	/mú	Ⓛ	gɔ̌p/	→	[mû	gɔ̀pə́]	'the child of the hen'
	/kòʔ˚	Ⓛ	gɔ̌p/	→	[kôʔ	gɔ̀pə́]	'the rooster of the hen'
	/gì	Ⓛ	gɔ̌p/	→	[gì	gɔ̀pə́]	'the voice of the hen'
	/dyə̌	Ⓛ	gɔ̌p/	→	[dyə̂	gɔ̀pə́]	'the house of the hen'
b.	/thə́	Ⓗ	gɔ̌p/	→	[thə́	ꜜgɔ́p]	'the head of the hen'
	/mkòʔ˚	Ⓗ	gɔ̌p/	→	[mkòʔ	gɔ́p]	'the roosters of the hen'
	/kwə̀	Ⓗ	gɔ̌p/	→	[kwə̀	gɔ́p]	'the foot of the hen'
	/tằŋ	Ⓗ	gɔ̌p/	→	[tằŋ	ꜜgɔ́p]	'the ear of the hen'

Further recordings made by Ghomala' language advocates and teachers confirm this distribution in morpho-phonological alternations. Consider the following recording made publicly available on YouTube, titled *Animaux en ghomala.*[3] The speaker (Kamdem Wambo) speaks in the Baham variety, also part of the central Ghomala' dialect very closely related and geographically proximate to Bandjoun, the variety of focus up to this point. The recording is of individual names of common domesticated and wild animals within the Ghomala' environs, and contain several simple nouns and noun phrase spoken in isolation.

Several of these words involve a rising tone and/or an obstruent coda. Open syllables or syllables with sonorant codas that have rising tones surface as expected, e.g. [tsə̌] 'elephant' (at 9 minutes and 33 seconds into the video, i.e. 9'33") and [bàpdə̌m] 'rat' (3'15"). There are 28 instances of a root with an obstruent coda and all 28 comply with the expected patterns of epenthesis. Representative examples are in Table 13. This provides the individual word as it is pronounced in the video (with its location), and the corresponding entry in the Ghomala' dictionary (Eichholzer 2010). If the obstruent coda occurs with H, HL, L˚, or L tone then the form ends with a consonant, but if it occurs with a LH (e.g. [sə̂ pɔ̀bə́] 'castrated

[3]This is available at https://www.youtube.com/watch?v=M5S1Pmw4ND8. Numerous other Ghomala' language YouTube recordings exist, which we do not analyze in this paper.

goat') then it ends in an epenthetic vowel (with intervocalic voicing as well).

Table 13: Corroborating evidence from *Animaux en ghomala* video (Baham variety of Central dialect)

Tone	Example		Location	Form in Eichholzer (2010)
H	[nɔ́k]	'snake'	(13'31")	nɔ́k 'snake'
HL	[dzɔ̂p]	'hedgehog'	(16'20")	dzɔ̂p 'hedgehog'
L°	[ŋgàp°]	'antelope'	(11'12")	gàp° 'antelope'
L	[kwàk]	'jigger flea'	(32'02")	kwàk 'jigger' (Fr. *chique*)
LH	[sɯ̂ pɔ̀bə́]	'castrated goat'	(6'51")	sɯ́ 'castrate' & pɔ̌p~pɔ̀pə́ 'he-goat'

Moreover, Figure 5 shows that the root /gɔ̌p/ 'chicken' is realized with as [gɔ́p] with a high tone and no final epenthesis in isolation.[4] While this surface pronunciation of a rising tone as high is different from the data from the Bandjoun variety (see Tables 5 and 7), it actually supports our main thesis since there is co-variation between tone and epenthesis. This is confirmed by Figure 6 which is a noun phrase [mɯ̂ gɔ̀bə́] 'chick' (lit. 'baby chicken'). Here, the form is realized as [LH], with the low portion hosted on the lexical vowel and the high portion on an epenthetic vowel [ə].

3.4 Indeterminate data from verb inflection

To wrap up our presentation of tone-driven epenthesis in Ghomala', we should provide a final note on a set of indeterminate data from verb inflection. Unlike nouns, Ghomala' verbs roots have only a basic underlying H vs. L distinction (Nissim 1972: 79; Mba 1997: 78), a property it shares with other Bamileke languages (Elias et al. 1984: 62). Parts of the verbal system confirm the observations in the nominal domain, e.g. for L-toned roots the imperative is expressed with LH tone realized as a rising tone on roots like [pàá] 'carry on the back!' but with a [ə] on roots like [càpə́] 'insult!' (Nissim 1972: 80). However, other parts of the system complicate our generalizations.

Consider the data in (5) from Bessala & Moguo (2017) which show an alternation between an obstruent coda (a) and a final [ə] (b), involving the lexically

[4] Faint aspiration can be detected in the recording, on this and many other obstruent-final tokens. Due to noise in the recording however, it is more difficult to clearly see on the spectrogram. The indeterminacy of aspiration is notated as '(h)' in Figure 5.

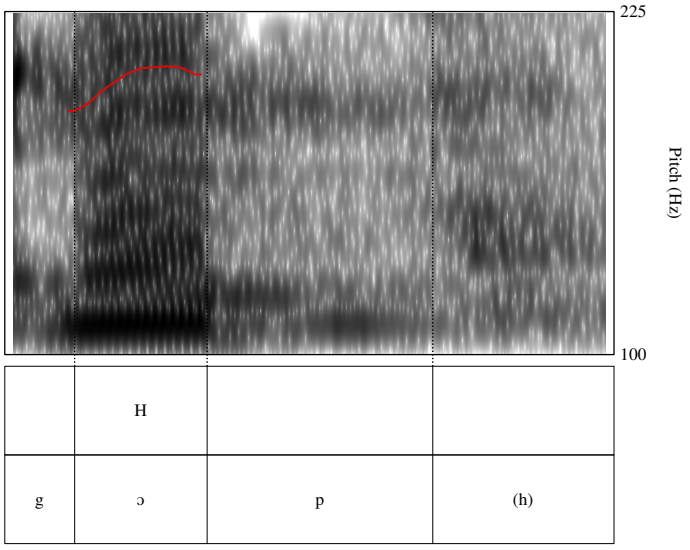

Figure 5: H tone without epenthesis – [gɔ́p] ‘chicken’ (24'28")

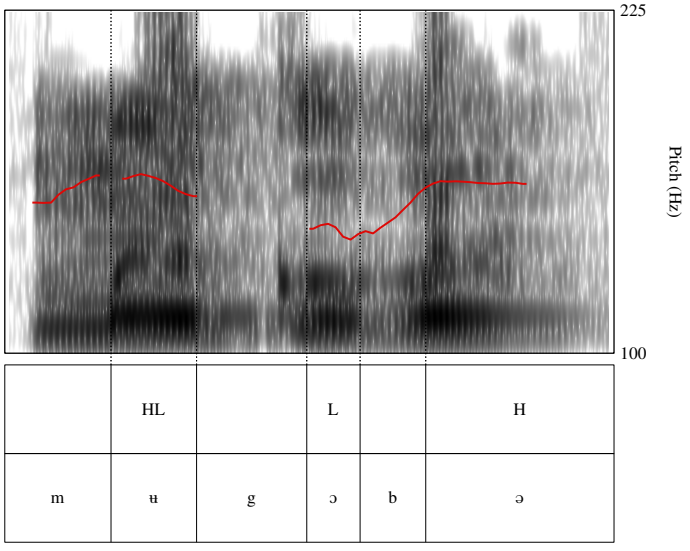

Figure 6: LH tone *with* epenthesis –[mʉ̂ gɔ̀bə́] ‘chick’ (25'10")

low-toned verb /ʒwɔ̀p/ 'dance'. Note that these examples follow the convention of transcribing the level low tone (i.e. L°) as a mid tone. There are other orthogonal changes as well, such as initial consonant changes.

(5) a. bájə̄ pō **ʒwɔ̄p** áá, bə̄ gâ nə̄ŋ
COND you **sing** DEF COND I dance
'If you sing then I will dance' (Bessala & Moguo 2017: 153)

b. tâmō bə̄ wə̄ **dʒwɔ́pə́**
Tamo COP PROG **sing**
'Tamo is singing' (Bessala & Moguo 2017: 151)

While the form in (a) without epenthesis follows straightforwardly from our analysis, the form in (b) is unexpected since this shows a final [ə] not co-occurring with a LH tone. In other words, we cannot attribute the presence of [ə] here to the avoidance of a rising tone on a syllable closed by an obstruent.

The presence of this inflectional 'final vowel' has been noticed already within the Ghomala' literature (Bessala & Moguo 2017; Kamdem 2020: 100), but at this point its presence function and distribution are not established. To complicate things further, variability is rampant even within the same inflectional context. For example, one context where this final vowel appears is with lexically low-toned roots in the infinitive, e.g. e.g. /càp/ 'insult' becomes [šápə̀°] 'to insult' (Nissim 1972: 77). While Nissim more or less consistently transcribes final vowels in such infinitival contexts, in sources such as Mba (1997) there is no indication of such vowels in equivalent contexts. This is exemplified in Table 14, which shows that while no final vowel appears in either source with roots of the H tone class (a), there is variability in the L tone class (b).

Table 14: Variation for infinitive forms across sources

	Tone class of root		INF (Nissim 1972)	INF (Mba 1997)	Meaning
a.	H	fí?	[fì?°]	[nə́-fî?]	'to descend'
b.	L	fì?	[fí?ì°]	[nə́-fì?]	'to water'
		vɔ̀k	[bvɔ́χə̀°]	[nə́-vɔ̀k]	'to live (on)'

Due to such complications with verb inflection, we have focused our attention on the nominal domain for this chapter.

4 Support for tonal features

The tone-driven epenthesis analysis supports an independently-posited proposal: tone features. Such features can be used to capture the six-way distinction in roots – i.e. /H/, /ˈH/, /L°/, /L/, /HL/, and /LH/, from Table 2 – in particular those which involve modifications of H and L tones. While we contend that Ghomala' tone should be deconstructed into tonal features, let us be clear that we are not claiming that *all* tonal languages should necessarily be deconstructed in this way.

The most important question for our study is the following: how do we represent the distinction between /ˈH/ vs. /L°/ vs. /LH/ tones? In individual languages, a downstepped high and a level-toned low are often treated as having floating tones before or after them to account for their contrast against plain H and L. In early work on Grassfields languages, Hyman & Tadadjeu (1976: 63-65) analyze Ghomala' LH as a composite /L+H/ sequence associated to a single tone-bearing unit (for our purposes, the vowel). In contrast, ˈH is rendered as Ⓛ+H with a floating low tone unassociated to the vowel, and L° as a L+Ⓗ with a floating high tone. This three-way contrast is shown in Figure 7.

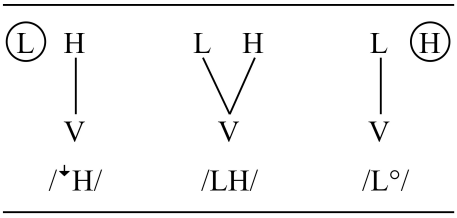

Figure 7: Three-way contrast analyzed with floating tones (after Hyman & Tadadjeu 1976: 63-65)

Let us see why the representation in Figure 7 is insufficient. As established, when a pre-linked /LH/ sequence is in an obstruent-final syllable then the H delinks from the lexical vowel and reattaches to a final epenthetic vowel. In this case, there is a new link between a H tone and the epenthetic vowel. This is shown in the leftmost representation in Figure 8. In contrast, with /Lˈ/ no epenthesis is ever conditioned (indicated by the asterisk in this figure), i.e. words like /bàp°/ 'animal' are never realized as [bàpə́]. Under the analysis from Figure 7, the difference in the representations would be whether the H is unlinked in the input – what we can call an underlying unlinked tone (or underlyingly floating) – versus whether the H becomes unlinked – a derived unlinked tone. Herein lies the discrepancy: underlying unlinked tones would *not* condition epenthesis while derived unlinked tones would condition it, despite being essentially the same

representation. The question then is: why would a H tone linking to a vowel be dependent on whether it was linked in a previous stage (i.e. its derivational history)?

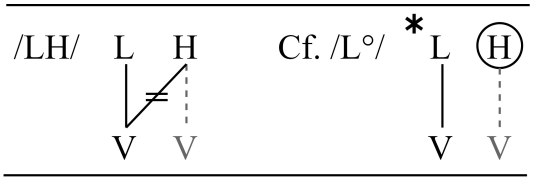

Figure 8: Discrepancy with derived vs. underived unlinked H

To avoid this shortcoming, we instead propose that the difference is not based on whether the tone is linked or not (whether underlyingly or derived), but rather is due to distinct tonal features. A prominent theory of tonal features is 'Register Tier Theory' (Snider 1988; 1990; 1999; see also Bao 1999 for historical context). The central premise of this model is that there are two tiers which contain qualitatively distinct tonal features. One is simply the 'tonal tier' which hosts familiar tonemes such as H and L, and the other is the 'register tier' containing register features denoted with lower case h and l. Register features are used to encode 'register shift' of pitch targets higher or lower compared to the previous register, specifically useful for capturing three or more contrastive pitch heights and phenomena such as downstep and upstep (Snider 1999: 25). For example, Figure 9 illustrates a four-height tone system where the highest pitch involves two features [H,h] and the lowest as [L,l], with intermediate pitches [H,l] (a higher mid) and [L,h] (a lower mid). No privative 'M' (or 'm') feature is used for mid tones, nor any other features for other degrees (e.g. for super high or super low).

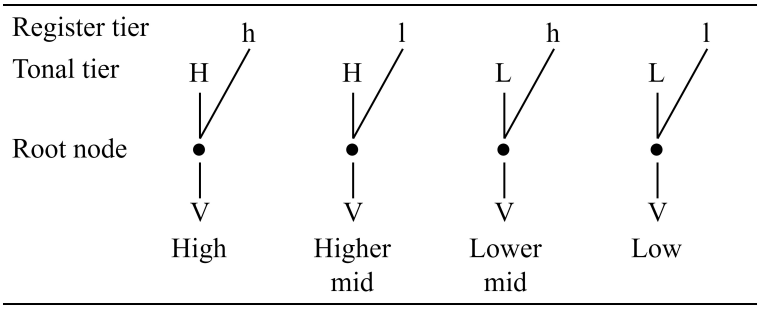

Figure 9: Four-way height contrast *via* tonal features (Snider 1999)

With this geometry in mind, let us return to the Ghomala' contrast between

/ˈH/, /L°/, and /LH/. In Figure 11, the downstepped high tone can be represented as a [H,l] sequence (with a neutralizing rule with high tone [H,h] in isolation), while the level low tone can be represented as [L,h]. In this figure, we use words /ˈdhə́/ 'spouse' and /bàp°/ 'animal' previously introduced in Table 2.[5] Minimally different is the LH tone, which can be represented compositionally as a L tone and a H tone (each with their own tonal root node), both associated to the same vowel. This is illustrated with /gɔ̌p/ → [gɔ̀pə́] 'hen' in Figure 11.

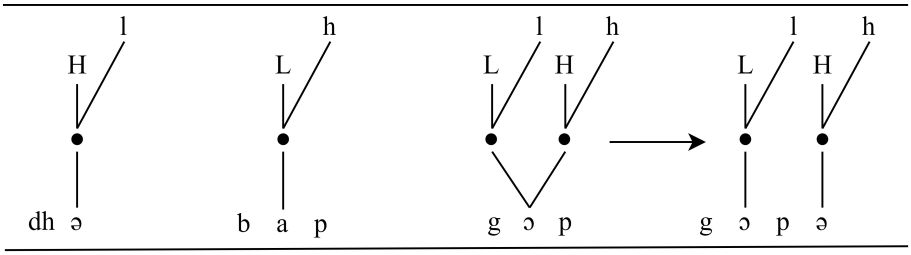

Figure 11: Analysis of ˈH (e.g. ˈdhə́) vs. L° (e.g. bàp°) vs. LH (e.g. gɔ̌p)

The crucial difference between these three representations is that although the first two have high and low components they are of different types, namely tonal tier and register tier features. In contrast, the last contains two tonal tier features associated to the same vowel, a representation to which we can localize our constraint, in (6).

(6) *[cV̌ʀ]: A linear sequence of tonal tier features L H do not associate to a vowel in a syllable closed by an obstruent coda

Given the variation in the realization of cV̌ʀ sequences (Table 5), we interpret this constraint as a gradient dispreference rather than a categorical prohibition.

In Ghomala', violations of *[cV̌ʀ] can be repaired by inserting a minimal vowel (either [ə] or a copy vowel) to host a tonal tier feature (i.e. [H]). Because the downstepped high and level low tone contain features on separate tiers, they do not form a linear sequence and therefore (6) does not apply to them. Therefore, the decomposition of tonemes into distinct features correctly predicts that they

[5] This latter representation [L,h] is the one actually posited by Snider (1999: 127) for cognate L° roots in the Grassfields language Bamileke-Dschang [ybb]. While this is one possibility, we emphasize that we are *not* claiming this representation should universally hold across all (Grassfields) languages. An anonymous reviewer rightly points out that in languages such as Fe'fe' [fmp], a level low tone L°becomes LH before a L, which suggests that it possesses a true floating H tone (or perhaps a floating [H,h] complex).

may have distinct behavior and subject to different constraints. Models without features struggle to capture these differences.

5 Tone-driven epenthesis in a typological perspective

Citing evidence from root phonotactics as well as morpho-phonological alternations, we have argued in the previous sections that Ghomala' has a dispreference for *[CV̌K] structures involving a rising tone on a syllable closed by an obstruent. To avoid such structures it will insert a final vowel to host the H tone, constituting what we termed tone-driven epenthesis. In this section, we situate these Ghomala' patterns within the larger typology of tone and tonal rarities.

5.1 A common constraint: Rising contours on closed syllables

The *[CV̌K] constraint of Ghomala' is part of a general cross-linguistic tendency to avoid rising contours on inadequate hosts. The phonetic underpinnings of this constraint are well-known. In a typological survey on tonal contours, Zhang (2013) notes that the main phonetic correlate of tone is fundamental frequency (i.e. f_0), and rich harmonic structures are crucial to the perception of f_0. Because sonorous segments such as vowels and sonorants possess richer harmonic structures than obstruents, they make for better tone-bearing units as the pitch targets are better perceived on them. Moreover, it is also well-known that among complex tone structures, a rising pitch takes longer to execute than a falling pitch and consequently has greater duration on average (e.g. Sundberg 1973). Taking these two aspects together, [CVK] structures may not provide enough sonorous material to adequately realize the rising tone within its allotted duration.

These inherent phonetic factors account for the general markedness of rising contours in the world's languages. In his contour tone survey, Zhang (2013) states languages that only allow surface falling tones (n=37) exceed languages that only allow surface rising tones (n=3). This markedness is also reflected in various implicational tendencies on contours generally, e.g. the finding of Gordon (2001: 428) that "if a language allows contour tones on CV, it also tolerates them on CVO, CVR, and CVV".

In response to such phonetically motivated pressures, the simplest situation are languages which unequivocally prohibit [CV̌K], and their morpho-tonology is such that they cannot result due to morpheme concatenation. Here, no repair can be identified. Most languages however provide evidence for a type of repair for prohibited [CV̌K] sequences. One common repair involves compression, sim-

plification, or flattening of the rising contour. Zhang (2013) discusses flattening of contour tones which may result in complete neutralization with another tone, e.g. in Xhosa [xho] HL contours are merged with H tones when a vowel is shortened in an unstressed (i.e. pre-penultimate) environment (Lanham 1958; 1963). In other languages, the contour may be simply compressed, thus preserving the tonal contrast.

Particularly widespread is a second repair involving vowel lengthening. For example, Zhang cites non-neutralizing lengthening in Mitla Zapotec [zaw] for syllables with rising but not falling contours (Briggs 1961). In the Africanist context, this is often framed as mora insertion. In Gokana [gkn] (Delta Cross, Niger-Congo: Nigeria), genitive constructions involve the juxtaposing a head noun followed by a modifying noun (parallel to the Ghomala' patterns from Table 9), exemplified in Table 15. Hyman (2011: 74) shows there are no tonal changes with H- and L-toned head nouns (a-b), but M-toned nouns are marked with a L grammatical tone (c). If there are enough moras to accommodate the grammatical tone then the tone simply falls on the final mora, but in monomoraic nouns (e.g. /tɔ̄/ 'house') there are not enough to accommodate both tones. In this context (and this context alone), a mora is added to host the tone resulting in a long vowel.

Table 15: Tone-driven mora insertion in Gokana (Hyman 2011: 74)

	Tone	Head noun			Genitive		Translation
a.	H	té	'tree'	→	té	nɛ̄n	'tree of person'
b.	L	gɛ̀	'knife'	→	gɛ̀	nɛ̄n	'knife of person'
c.	M	tɔ̄	'house'	→	**tɔ̄ɔ̀**	nɛ̄n	'house of person'
		mɛ̄n	'neck'	→	mɛ̄ǹ	nɛ̄n	'neck of person'
		mīī	'blood'	→	mīì	nɛ̄n	'blood of person'
		kīgī	'axe'	→	kīgì	nɛ̄n	'axe of person'

5.2 A rare repair: Tone-driven epenthesis

While a phonetically-natural constraint like *[cv̌ʁ] is quite common, tone-driven epenthesis as a repair to this constraint is quite rare if not unprecedented. No such repair appears in either of the typological surveys mentioned above (Gordon 2001; Zhang 2013), nor does it appear in reference works on tone (e.g. Pike 1948; Fromkin 1978; Yip 2002; Wee 2019; *inter alia*) or epenthesis (e.g. Broselow 1982; Itô 1989; Blumenfeld 2006; De Lacy 2006; Hall 2006; Hall 2011; *inter alia*). In

fact, works which posit a maximally restrictive theory of epenthesis assume tone-driven epenthesis to be impossible/unattested (Blumenfeld 2006; Gleim 2019). Blumenfeld concludes that epenthesis is "used exclusively as a response to pressures of syllable structure, sonority sequencing, syllable contact, and word minimality" (p. 5), but that "tone conditions cannot affect string structure" and therefore tone "cannot force epenthesis/syncope" (p. 41).

From this backdrop it is quite remarkable that an epenthetic vowel in Ghomala' appears in order to host part of a pitch contour rather than solely due to segmental or syllabic markedness conditions. Other than Ghomala', we are aware of only four potential cases of tone-driven epenthesis: in Wamey, Kejom, Barain, and Arapaho. Of these, only Wamey is as convincing as the Ghomala' case.

Wamey [cou] (also called Konyagi/Coniagui) is a language of Guinea and Senegal traditionally placed in the "Atlantic" group of the Niger-Congo phylum. Building on analysis and description in Santos (1996), Rolle & Merrill (to appear) provide a number of arguments parallel to those developed for Ghomala', showing that rising tones on closed syllables trigger epenthesis. First, there are restrictions on the shape of roots based on tone. Wamey has a basic H vs. L tone contrast, and HL and LH contours are common. As summarized in Table 16, CVC-shaped roots may bear H, L, or HL tones, but no CVC root appears with LH tones. At the same time, bisyllabic CVCə-shaped roots are not permitted with H, L, or HL patterns, but only appear with LH root tones.

Table 16: Wamey language (Santos 1996) – Complementary distribution of CVCə and CVC root shapes based on tone

	Tone	[CVCə] shape		[CVC] shape	
a.	H	*cv́cə́		[-cə́w̃]	'urinating'
b.	L	*cv̀cə̀		[-cə̀w̃]	'hiding'
c.	HL	*cv́cə̀		[-cə̂w̃]	'domestic animal'
d.	LH	[-nkə̀w̃ə́]	'dance' (n.)	*-cv̌c	

This complementary distribution is naturally captured via a unified underlying representation /CVC/ for all four root types, plus tone-driven [ə] epenthesis to avoid a rising tone on a closed syllable. As in Ghomala' the overwhelming majority of roots are monosyllabic. Those CVCV structures which cannot be attributed to the epenthesis operation are either morphologically complex or are loanwords.

Furthermore, as in Ghomala' we cannot attribute the epenthesis procedure

to segmental phonotactics which prohibit certain consonants in coda position. A syllable closed by any consonant shows epenthesis when appearing with a rising LH tone (not just with obstruents as in Ghomala'). All consonants are otherwise allowed in coda position, even perceptibly difficult ones like implosive /ɓ/ (7). (Note that the prefixes are noun class markers, not relevant to our discussion).

(7) a. H [ì-gwǽlǽɓ] 'to talk a lot'
b. L [ì-còɓ] 'to stick on'
c. HL [æ̀-kæ̂ɓ] 'rubber vine'
d. LH [æ̀-kæ̀ɓǽ] 'type of owl' (*Otus leucotis*)

Moreover, Wamey also demonstrates morpho-phonological alternations which support the equivalency of coda-final and [ə]-final forms. For example, the suffix /-k/ (roughly third singular perfective) is one of several suffixes which show alternations of the type [-k]~[-kə́]. The data in (8) are representative for the distribution of the two variants: the [-k] form appears if the preceding vowel is high-toned (a) while the [-kə́] variant appears if the preceding vowel is low-toned (b).

(8) Tone-driven alternations in Wamey (Santos 1996: 43)
a. After [H]: ì-cǽs 'to suffer' ⟶ **cǽsə́-k** 'he suffers'
b. After [L]: ì-tòk 'to eat' ⟶ **tókə̀-kə́** 'he ate' (cf. *tókə̆-k)

Such alternations are accounted for if we posit that the final schwa in (b) is inserted in order to avoid a rising tone on a syllable closed by /-k/ (see Rolle & Merrill to appear for extensive argumentation).

While Wamey is a strong candidate for tone-driven epenthesis, the three other cases are weak and only superficially resemble it. The first is another Niger-Congo language closely related to Ghomala', namely Kejom [bbk] (also called Babanki – Grassfields, Bantoid: Cameroon). The relevant data involve various paradigms from verb inflection, such as the imperative which Akumbu et al. (2020) analyze as involving a floating Ⓗ tone which appears after the verb (specifically the non-indicative singular imperative). Imperative data are in (9) If Ⓗ appears with a high-toned root (e.g. /lám/ 'cook') no overt marking is seen, but if it appears with a low-toned root (e.g. /kùm/ 'touch') an overt inflectional suffix [-ə] appears. Note in this example there is high tone spreading onto the object's

noun class prefix /kə̀-/, resulting in a surface mid tone.

(9) Non-indicative singular imperative in Kejom (Akumbu et al. 2020: 11)
   a. H root: /lám ⓗ kə̀-báyn/ ⟶ [**lám** kə̄-báyn] 'Cook the fufu!'
   b. L root: /kùm ⓗ kə̀-báyn/ ⟶ [**kùmə́** kə̄-báyn] 'Touch the fufu!'

Akumbu et al. (2020: 3) specifically characterize this distribution as lexically low verb roots having "acquired an epenthetic schwa to avoid the rising tone that would otherwise result from combining the root L with the H suffix tone of the imperative (**kŭm*)".

However, one aspect of Kejom which makes it distinct from Ghomala' and Wamey is that this epenthesis process is morphologically restricted. For example, in the analogous context under negation, no epenthesis is found.

(10) Non-indicative negative singular imperative (Akumbu et al. 2020: 14)
   a. /ká à lám ⓗ kə̀-báyn/ ⟶ [ká ↓**lám** kə̄-báyn] 'Don't cook the fufu!'
   b. /ká à kùm ⓗ kə̀-báyn/ ⟶ [ká **kùm** kə̄-báyn] 'Don't cook the fufu!'

As Akumbu et al. (2020) make clear, the same imperative floating ⓗ must be present since it conditions tonal changes on the object. In total, if tone-driven epenthesis were fully general in Kejom, we would expect the unattested form *[kùmə́] in (10b), contrary to fact.

Finally, two other potential cases of tone-driven epenthesis are Barain [bva] (Chadic: Chad – Lovestrand 2012) and Arapaho [arp] (Algonquian: USA – Cowell & Moss 2008; Gleim 2019). Taking Barain first, tone alone cannot condition epenthesis but rather only makes otherwise variable segmentally-driven epenthesis obligatory. Lovestrand (2012: 21) details the strict requirements on complex onsets and codas, showing that an epenthetic vowel is inserted to satisfy these requirements. In (11), [i] is inserted to break up the heteromorphemic consonant sequence.

(11) Barain epenthesis (Lovestrand 2012: 44):
   /wi̋ls-gà/ boil-DO:3.M ⟶ [wīlsígà]

Speakers differ as to whether they condition epenthesis in such heteromorphemic contexts. A coarse generalization is that younger speakers consistently insert epenthetic vowels in such cases while older speakers show considerable variation. This is exemplified in Table 17 with two speakers, A (of the younger generation) who consistently shows epenthesis and B (of the older one) who is more variable.

Table 17: Barain epenthesis co-driven by both segmental structure and tone (Lovestrand 2012)

	Morphemes	Gloss	Speaker A	Speaker B (Older gen.)
a.	/séébtì/	fish-DO:3.F	[séébítì]	[séébítì] ~ [séptì]
	/ēpgà/	punish-DO:3.M	[èpìgà]	[èpìgà] ~ [èpgà][a]
	/pā́snù/[b]	miss-DO:1.S	[pásùnù]	[pásùnù] ~ [pásnù]
b.	/séébⓂgà/	fish-IPFV-DO:3.M	[séébìgà]	[séébìgà] (cf. ?[sébgà], *[séèbgà])
	/dópⓂgà/	find-IPFV-DO:3.M	[dópìgà]	[dópìgà] (cf. ?[dópgà])

[a] A regular tonological rule changes M to L before L.
[b] The lexical tone mark on /pā́s/ represents a HM falling contour.

Importantly, Lovestrand (2012: 63) states that even "those speakers who allow the unlicensed cluster still prefer the epenthetic vowel in the case where not using the epenthetic vowel would create a word with fewer [tone-bearing units] than underlying tones". One example involves the imperfect aspect realized as a floating Ⓜ tone (row b from Table 17). When such a floating tone is present, epenthesis is required by all speakers and its absence is questionable/ungrammatical. Thus, in Barain tone alone cannot condition epenthesis in the first place but rather increases the preference for it.

A similar case is in Arapaho, which superficially resembles tone-driven epenthesis but is better understood as 'tone-driven retention' whereby vowels that are otherwise expected to delete and/or reduce according to the regular phonology are retained if and only if they bear tone. Several such cases have previously been identified in Roettger & Grice (2019: 279-280), e.g. in Cheyenne [chy], Acoma [kjq], Konso [kxc], Shanghainese [wuu], and Japanese [jpn], to which we can add Arapaho. Our presentation of the Arapaho data follows the argumentation developed in Gleim (2019).

In Arapaho, certain morphemes idiosyncratically co-occur with a floating high tone, shown in Table 18. When this floating high cannot find an appropriate host tone-bearing unit (as determined by the tonal grammar), it appears on an epenthetic vowel [i]/[u]. In (a), the epenthetic vowel and its surrounding consonants are in bold. In contrast, if the morpheme does not sponsor a floating tone then no surface epenthetic vowel occurs (b). Such data demonstrates a co-occurrence of floating tones and epenthetic vowels, which reasonably could suggest tone-driven epenthesis.

Table 18: Arapaho epenthetic vowels and floating tone (after Gleim 2019)

a.	/tʃew-Ⓗsee/	[tʃe**bí**see]	'to walk along'
	/oow-Ⓗsee/	[hoo**wú**see]	'to walk downward'
	/néé?eeθ-Ⓗnihíí-noo/	[néé?ee**sí**nihíínoo]	'that's what I'm saying'
b.	/étʃex-nówo?/	[hétʃe**s**nówo?]	'small fish'
	/nih-bebíiθ-tii-t/	[nihbebíi**st**iit]	's/he fixed it'
	/tʃew-kóóhu/	[tʃe**bk**óóhu]	'run along'

Despite appearances, Gleim (2019) argues that epenthesis is not triggered by the floating tone here, but rather it is merely retained by it (building on original observations in Cowell & Moss 2008: 16). The crucial evidence comes from a develarization process apparent from Table 18: velar segments /x/, /k/, /w/ become [s], [tʃ], [b] before front vowels [i] and [e]. Crucially, develarization takes place both before surface [i] (e.g. [tʃe**bí**see] in a, where /w/⟶[b]), as well as opaquely applying where no surface vowel appears (e.g. [hétʃe**s**nówo?] in b, where /x/⟶[s]).

Gleim shows that the opacity can be accounted for straightforwardly if we assume a 'Duke-of-York derivation' (Pullum 1976), where an operation of vowel epenthesis applies first and uniformly, followed by floating tone docking and develarisation. After these operations, an operation of high vowel deletion takes place if the high vowel does not bear high tone (hence tone-driven retention). Because this deletion process can target an epenthetic vowel, the underlying form and the surface form look alike, characteristic of all Duke-of-York examples in the literature (i.e. of the type A⟶B⟶A).

To summarize, in Kejom tone-driven epenthesis is not fully general and is rather morphologically restricted, in Barain the tone alone cannot condition epenthesis but rather only makes otherwise variable segmentally-driven epenthesis obligatory, and in Arapaho what resembles tone-driven epenthesis is actually tone-driven retention, supported by evidence from Duke-of-York effects. Ghomala' and Wamey have none of these shortcomings.

6 Why is tone-driven epenthesis so rare?

Why is tone-driven epenthesis so rare? Its existence in Ghomala' (and Wamey) entails that we cannot prohibit it absolutely, such as through Universal Grammar conditions on phonological architecture. Moreover, as shown in Section 1

its counterpart intonation-driven epenthesis has been proposed several times. To repeat our discussion of Tunisian Arabic (1), Hellmuth (2022) shows that epenthesis only appears in the context of a complex rise-fall intonational contour (i.e. L*+H H-L%), and *never* appears when there is only a simple rise or simple fall, showing clear co-variation between a final vowel and a complex pitch event.

In this section, we entertain three possible avenues of explanation for the rarity of tone-driven epenthesis (not mutually exclusive): the (relatively) low functional load of tone, the analytic indeterminacy of epenthesis, and the potential for tone to find pre-existing hosts.

6.1 Explanation 1: Low functional load of tone

The first avenue of explanation has to do with contrast, specifically that for many tone languages there is little reason to excessively maintain tone contrast. In tonal languages, most morphemes bearing tone are expressed jointly by tonal and segmental material together, and more rarely by tone alone. If there is enough segmental material to differentiate the morpheme from other paradigmatically-related morphemes (e.g. all nominal roots, or all TAM suffixes), then adding more segmental material via epenthesis may be costlier than being faithful to the underlying tone pattern; the result may be tone deletion. In short, in most tonal languages if the H portion of a [cv̌k] sequence were simply deleted, little information would be lost to correctly identifying the intended lexical meaning.

Compare this to intonation. In contrast to tone, the 'intonemes' of intonational systems normally do not occur with segmental co-exponents. A consequence of this is that losing cues for the intonational melody is more costly since there would be no additional segmental cues. To avoid this, post-lexical epenthesis would appear to be a reasonable repair.

This discussion can be situated within a larger discussion of the 'functional load' of phonological contrasts (Hockett 1955; 1966; Wedel et al. 2013; Hall et al. 2019). Characterized in these terms, the functional load of tone in tonal languages is lower than the functional load of tone in intonational languages. From our study, this implies that the functional load of tone in Ghomala' (and Wamey) for lexical tone contrasts should be higher than other tonal languages (on average). Testing this hypothesis requires another study unto itself. In fact, there are almost no quantitative studies of the functional load of tone in tonal languages, and those which do exist focus on Chinese languages (Surendran & Levow 2004), whose tone systems are known to be typologically distinct from other tonal languages (Hyman 2018).

6.2 Explanation 2: Analytic indeterminacy of epenthesis

Relatedly, the rarity of epenthesis may be attributed to the propensity for the epenthetic vowel to be reinterpreted as underlying (and thus no longer epenthetic).

To explain, consider a surface form like [gɔ̀pə́] 'hen' from Ghomala'. If a speaker interprets this as underlying /gɔ̀pə́/, then the speaker posits the ə and its tone H as belonging to the same underlying morpheme. These two pieces of phonological representation would be pre-associated in the lexicon. It is normal in tone languages for vowels to be pre-specified to tones, but the counterpart is exceptional in intonational systems (as stated in 6.1). Thus, in intonational systems the speaker is not likely to interpret ə and H as coming from the same morpheme (if they are interpreted as coming from a structural morpheme at all). What this boils down to is that a final [ə] is unlikely to be interpreted as inherently linked to an intonational contour, and therefore a speaker must interpret its presence as due to some other factor. A clear possibility is epenthesis.

However, even within intonation-driven epenthesis it is often not straightforward whether to interpret a final 'epenthetic' vowel as derived (through epenthesis) or as underlying (as part of the root, or some other morpheme). In the above-cited Tunisian Arabic (1), Hellmuth (2022) in fact deliberates over the final [ə] which co-varies with the complex rise-fall intonation, ultimately deciding it is "a 'question vowel' particle of some type" analogous to similar interrogative clitics in the area. The analytic indeterminacy of epenthesis is notoriously difficult (Morley 2015), which holds for both linguists and speakers. This indeterminacy is reflected by the fact that intonation-driven epenthesis – while less rare than tone-driven epenthesis – is still infrequent among the world's intonational systems.

6.3 Explanation 3: Intonation is more 'edge-bound' than tone

The final explanation we entertain focuses on a positional asymmetry between (lexical) tone and intonation. Morphemes carrying lexical tone may appear in various positions in a clause while intonation is often bound to a specific edge, e.g. the right edge of the intonational clause. The consequence of this is that tone has more opportunity to dock to surrounding material (e.g. words to its left or right) than edge-bound intonation. By docking to an already existing vowel, this obviates the need for epenthesis.[6]

[6] An anonymous reviewer points out however that there are languages that restrict contour tones to a pre-pausal syllable, and any underlying contours not in this position are leveled.

To illustrate, consider tone languages which have a contrast between plain low-toned words versus low-toned words which also have a floating Ⓗ tone. One such language is Ganza [gza] (Mao, "Omotic": Ethiopia – Smolders 2016), where this contrast can be seen in noun phrases expressing possession. In (12), L-toned /kùrù/ 'genet' causes no changes to the following word (a). In contrast, L-toned /wàŋà/ 'chicken' additionally has a Ⓗ after it which docks to the following word (b).

(12) Floating tone in Ganza docks to word to right (Smolders 2016: 134-135)

a. /kùrù tòkò/ → [kùrù tòkò] 'genet's foot'

b. /wàŋàⒽ tòkò/ → [wàŋà **tókò**] 'chicken's foot'

Smolders is explicit that the floating Ⓗ must attach to an available tone-bearing unit to the right, and is otherwise deleted. The floating tone does not attach to the first noun to create a rising tone, and the distribution of rising tones is quite limited generally in Ganza (Smolders 2016: 128, fn 40). In a tonal language like Ganza, marked rising tones can be avoided by simply docking the floating tone to some rightward element. In a hypothetical intonational language, no such rightward element is available (or accessible). To avoid a rising tone in such an intonational language, an epenthetic vowel may be inserted which would be unnecessary in a tone language without such an edge restriction.

7 Conclusion

This chapter focused on a little-known tonological rarity: tone-driven vowel epenthesis. We showed that in Ghomala', an epenthetic vowel is inserted to avoid a rising tone on syllable closed by an obstruent, i.e. /gɔ̌p/ → [gɔ̀pɔ́] 'chicken', but never triggered in other tonal contexts. We supported tone-driven epenthesis over competing alternatives like vowel-deletion, focusing on evidence from root phonotactics and morpho-phonological alternations which show that when a rising tone is modified the epenthetic vowel is lost (i.e. complete co-variation). Moreover, we showed that tone-driven epenthesis supports an independently-posited proposal for tone, including tone languages closely related to Ghomala': decomposing tonemes into tonal features. Finally, from a typological survey we demonstrated that avoiding rising tones on closed syllables is a common constraint, but tone-driven epenthesis as a repair for this constraint is rarely if ever found in the tone literature. We provided three possible explanations for its rarity, contrasting it against the more common intonation-driven epenthesis: the

(relatively) low functional load of tone, the analytic indeterminacy of epenthesis, and the potential for tone to find pre-existing hosts.

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[*To be added*]

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