Register and tone developments in Vietic languages

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To the Change

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Abstract

REGISTER AND TONE DEVELOPMENTS IN VIETIC LANGUAGES

Tan Ta, *University of Ottawa*

This dissertation studies the synchronic phonetics of the tonation systems of five Vietic (Austroasiatic) varieties, Arem (ISO: *aem*), Rục (ISO: *scb*), and three North-Central Vietnamese (ISO: *vie*) dialects, Cổ Định (Thanh Hoá province), Nghi Ân (Nghệ An province), and Diêm Điền (Quảng Bình province) with the aim of improving reconstructions of Proto-Vietic tonation.

Tonation is a cover term for *tone* and *register*, two phonological contrasts frequently encountered in many East and Southeast Asian languages. These two contrasts can be realized on the rhyme by differences in f0, phonation type, and duration, but also, especially in the case of *register,* by differences in vowel quality and by modulations of closure duration and voice onset time in onset consonants. Tone usually derives from the loss of laryngeal codas (*tonogenesis*), while register typically originates from the loss of voicing contrast in onset obstruents (*registrogenesis*). Onset devoicing can also lead to the formation of two-tone systems or double the number of tones in tonal languages. Different hypotheses have been advanced to explain the phonetic underpinnings of tone and register development, their shared phonetic properties, and intersecting segmental origins, but experimental evidence is needed to validate these hypotheses.

The results show that Arem contrasts high and low registers realized by means of a breathier phonation and more closed vowels in the low register. However, Proto-Vietic final glottals, *-ʔ, *-h, and glottalized sonorant codas are still preserved in the language, and their effects on duration, f0, and phonation of preceding vowels are too variable across registers and speakers to consider Arem as tonal.

The study of the tonation system of Rục shows that it has four tones in open and sonorant-ending syllables. These tones can be grouped into two high-register tones and two low-register tones that are distinguished by consistent differences in f0, phonation type, vowel quality, and to a lesser extent, vowel duration and VOT. The final fricative *-h is still preserved in Rục, and syllables ending in this coda exhibit no f0 difference, but they feature all other register properties. Hence, Rục has a hybrid system of tone and register. The results of the perception experiment reveal that Rục participants use the same phonetic cues in their perception as in their production of tonation, with roughly the same prominence for each cue.

I then turn to the three North-Central Vietnamese dialects and show that they have different numbers of tones and make use of different phonetic properties to realize these tones. Different post-tonogenetic changes also led to distinct tone mergers in these dialects. Traces of register-conditioned variation in phonation type and vowel quality are limited in these varieties, but the low-register tone A2 in Diêm Điền was found to preserve breathy phonation, which is likely to be a remnant of the low register in Proto-Việt-Mường. Vowel quality was found to be conditioned by the tense phonation of tones in the low f0 range in Cổ Định and Nghi Ân, but I argue that this is not a remnant of register, a conclusion strengthened by an investigation showing that there is little evidence for register-conditioned vowel changes from Proto-Vietic to modern Northern Vietnamese.

Since there is either a register contrast or remnants of register in all branches of Vietic, I propose to reconstruct a register contrast in Proto-Vietic, against previous proposals postulating that it had a voicing contrast. This register contrast evolved differently in different daughter languages and interacted with various patterns of retention

of laryngeal codas, resulting in diverse tonation systems in Vietic languages. By combining insights on the typology of tonogenetic effects gained from my investigation of Rục and Arem glottal codas and on evidence from correspondences between Chinese and Sino-Vietnamese tones, I further propose that tonogenesis from codas is likely to have happened in Proto-Việt-Mường from the 9th to 12th century CE, which is later than previous proposals.

List of Abbreviations

CPP	Cepstral peak prominence
EGG	Electroglottography(ic)
EMC	Early Middle Chinese
ESEA	East and Southeast Asia(n)
ESV	Early Sino-Vietnamese
LMC	Late Middle Chinese
LSV	Late Sino-Vietnamese
MC	Middle Chinese
OC	Old Chinese
OQ	Open Quotient
PVM	Proto-Việt-Mường
SV	Sino-Vietnamese

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Chapter 1

Introduction

This dissertation examines the synchronic status of several tonation systems in the Vietic family of the Austroasiatic phylum to answer hypotheses on tonation formation in East and Southeast Asian (ESEA) languages. Tonation (Bradley, 1982a) is a cover term that designates lexical contrasts that have traditionally been referred to as *tone* and *register* in the literature on ESEA languages. Although tonation is realized differently from language to language, in all cases, it makes use of laryngeal phonetic properties, like f0 height, f0 contour, phonation, and intensity, but also, as we will see, vowel quality and vowel duration, and modulations of onsets (closure duration and VOT).

Tonation systems in ESEA languages are usually claimed to derive from two distinct processes. The first process is the loss of final glottals -ʔ, -h, and glottalized sonorants that were reconstructed as the historical source of tone in Vietnamese (Austroasiatic) (Haudricourt, 1954b), Chinese (Tibeto-Burman) (Haudricourt, 1954a; Mei, 1970; Pulleyblank, 1978; Sagart, 1999), other Tibeto-Burman languages (Matisoff, 1970, 1973; Mazaudon, 1976), Hmong-Mien languages (Ratliff, 2010) and Kra-Dai languages (Gedney,

1986; Norquest, 2007; Sagart, 2019), among others. The second process is the loss of various laryngeal contrasts in onsets, like voicing (the most commonly attested), aspiration, and glottalization, that either led to the formation of various tonation systems in Austroasiatic (Henderson, 1952; Huffman, 1976; Ferlus, 1979a) and several Chamic (Austronesian) languages (Thurgood, 1996, 1999; Brunelle, 2005; Brunelle, Tạ, Kirby, & Đinh, 2020; Brunelle, Brown, & Hà, 2022a), or doubled or tripled the number of tones in languages like Vietnamese, Chinese, and Tai (Haudricourt, 1954b, 1972 [1961]; Gedney, 1989). Although there are fairly uncontroversial scenarios explaining the formation of tonation systems, their phonetic underpinnings are not always clear, and some of the phonetic mechanisms that have been proposed to account for them require more systematic investigation.

In this dissertation, I focus on Vietic, a family of the Austroasiatic phylum, since all languages in this family have some form of tonation and illustrate different stages of tonation formation (Ferlus, 1998b). This allows me to investigate a wide range of synchronic tonation systems and draw inferences about tonation formation in general. I conducted production studies on the tonation systems of five Vietic varieties, Arem /arem/, Rục /ruk꜒/, and three North-Central Vietnamese dialects, along with a perception study of Rục, to better understand the phonetic processes leading to the development of Vietic tonation and revise current reconstructions of tonation in Proto-Vietic.

The rest of this introductory chapter is organized as follows. First, I introduce concise and non-technical descriptions of tone and register and the processes leading to their formation, tonogenesis and registrogenesis, in Section **1.1**. I then provide the readers with a brief overview of tonation systems in the Austroasiatic phylum and its Vietic family in Section **1.2**. In Section **1.3**, I explain why Vietic is important to the study of tonation and

its formation in ESEA languages. I provide the specific reasons for choosing the varieties studied in this dissertation. The general research questions of the dissertation are laid out in Section **1.4**. I sketch out the dissertation structure in Section **1.5** and summarize new findings and contributions of the dissertation in Section **1.6**.

1.1 Tonation: basic concepts

1.1.1 Tone and tonogenesis

Simply put, lexical tone is the use of pitch[1] changes to differentiate the meanings of morphemes that are otherwise phonetically identical. This dissertation will not address other forms of tone, such as intonational pitch-accents (Selkirk, 1984; Selkirk, 1995), boundary tones (Pierrehumbert, 1980), and grammatical tone (Hyman, 2016; Rolle, 2018). Tone languages differ in the number of distinctive tones in their inventories (tonemes) and their contrastive properties. The most frequently encountered phonetic properties of tone in ESEA languages are f0 height, f0 contour, duration, and phonation type. Tone languages can also more rarely have tone-vowel cooccurrences, such as Fuzhou Chinese (Donohue, 2017), the West Hmongic (Hmong-Mien) language Zongdi (Ratliff, 2010), and Rục (Vietic) (Nguyễn, 1993; Solntsev, Solntseva, & Samarina, 2001a; Tạ, 2021).

A fairly typical ESEA tone system is exemplified by the Northern dialect of Vietnamese, which has six tones in open and sonorant-ending syllables (i.e., unchecked syllables). The main phonetic properties that differentiate these tones are f0 height, f0

[1] Pitch: the human perception of the fundamental frequency of sounds, which ultimately articulatorily depends on the vibration rate of the vocal folds. From now on, I will use *f0* (fundamental frequency) and *pitch* to refer to the events of speech production and perception, respectively.

contour, and phonation. A minimal set of words composed of the six tones on the monosyllable *ma* is given in Table 1-1. Figure 1-1 shows their f0 tracks and waveforms.

Table 1-1. Six tones of Northern Vietnamese.

Native spelling	*Gloss*	*Native tone name*	*Description of tone*
ma	*ghost*	ngang	high level
mà	*but*	huyền	low falling
má	*cheek, mother*	sắc	mid rising
mạ	*seedling*	nặng	mid falling, ends on a glottal constriction
mả	*grave*	hỏi	low falling-rising with mild middle glottalization
mã	*horse, appearance*	ngã	mid falling-rising, interrupted by a strong glottal constriction

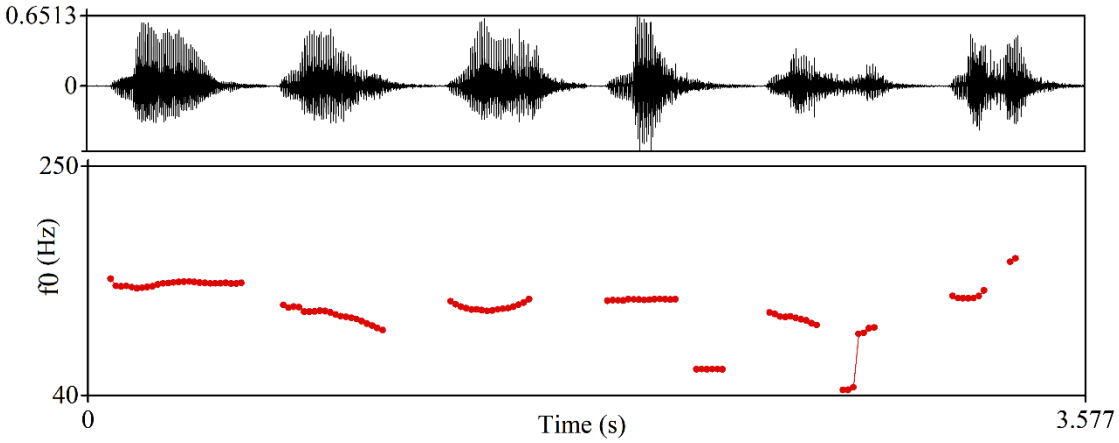


Figure 1-1. Sound wave and f0 tracks of the six unchecked Northern Vietnamese tones produced by the author on syllable [ma]. From left to right: *ngang, huyền, sắc, nặng, hỏi, ngã*. Glottalization in *nặng, hỏi, ngã* can be observed from the shape of their waveform and their disrupted f0 tracks.

Phonation plays a non-negligible role in the patterns of tonal contrast of Northern Vietnamese. Besides glottalization in tones *nặng, hỏi, ngã,* some studies show that a breathy phonation often accompanies the *huyền* tone in this dialect, although this varies between speakers (Vũ, 1981; Edmondson & Lợi, 1997; Pham, 2004).

Alongside the six tones found in unchecked syllables, there are two distinctive tones on syllables ending with a stop (i.e., checked syllables): *sắc nhập* and *nặng nhập*. They are considered allotones of *sắc* and *nặng* tones in traditional Vietnamese grammar and are treated as such in the Vietnamese alphabetical writing system. However, their phonetic properties and phonological behaviors are distinct from their open-syllable (unchecked) counterparts, and they form a subsystem in the tone system in their own right (more details are given in Chapter 6).

The tone systems of Central and Southern dialects differ from that of Northern Vietnamese in a few respects. Firstly, the two tones *hỏi* and *ngã* are phonetically identical in all non-Northern dialects, except Nghệ Tĩnh dialects in Central Vietnam. It is normally considered, implicitly or explicitly, that these two tones "merged" at some point, but as far as I know, no one has proposed any argument against the possibility that they were one and the same tone from the beginning. Some North-Central Vietnamese dialects have even more restricted inventories because their *hỏi-ngã* tone further merged with *nặng*. Additionally, while most Central Vietnamese dialects have glottalized tones, just like Northern Vietnamese, the Southern dialects have no such phonation contrasts (Vũ, 1981; Honda, 2006; Brunelle, 2009; Kirby, 2011).

The formation of tone in a previously atonal language is called *tonogenesis*, a term coined by Matisoff (1973). The first observations about tonogenetic mechanisms seem to be attributable to Maspero (1912), who discovered correspondences between groups of tones in Sino-Vietnamese, the Vietnamese rendering of Chinese characters, and Old Chinese voiced and voiceless onset stops. He also pointed out a correspondence between Vietnamese *hỏi-ngã* and Austroasiatic words ending in the finals -h and -s. Haudricourt

(1954b) picked up on these insights and developed the first hypothesis outlining how (Northern) Vietnamese obtained its tone system. This hypothesis was then applied to Chinese by the same author (Haudricourt, 1954a) and extended to other ESEA tone languages (Matisoff, 1973; Mazaudon, 1976; Gedney, 1986; Ratliff, 2010; Sagart, 2019).

According to Haudricourt (1954b), Vietnamese tones arose from the loss of the glottal codas -ʔ and -h and onset devoicing. The loss of the final glottals -ʔ and -h gave way to a rising and a falling tone contrasting with a level tone found on originally open syllables. Then, the number of tones was doubled due to the loss of a former voicing contrast in onsets that conditioned low (< *voiced[2]) and high (< *voiceless) tones[3]. The onset and coda origins of Vietnamese tones, according to Haudricourt, are schematized in Table 1-2 and explained in detail in Chapter 2.

Table 1-2. Coda and onset origins of Vietnamese tones, along with their proposed contours right after completion of tonogenesis, according to Haudricourt (1954b).

	-ϕ	***-ʔ***	***-h/s***	***-p/t/k***
**Voiceless onset*	Ngang *High level*	Sắc *High rising*	Hỏi *High falling*	Sắc nhập *High rising + stop*
**Voiced onset*	Huyền *Low level*	Nặng *Low rising*	Ngã *Low falling*	Nặng nhập *Low falling + stop*

The laryngeal properties of onsets and codas are not the only possible sources of tonogenesis. In other Austroasiatic languages, tones arose from the loss of other phonemic distinctions not found in Vietic. These include mergers between *vowel heights* in Katuic languages (Diffloth, 1982; Sidwell, 2005; Gehrmann, 2015) and the Palaungic language U

[2] The asterisk (*) is used to denote reconstructed forms.
[3] The problem of the relative order of the two processes will be discussed in Chapter 2.

(Svantesson, 1988, 1989), neutralization of *vowel length* in the Palaungic language Hu (Svantesson, 1989, 1991), or the shift of the medial -r- to -h- in Phnom Penh and Kiên Giang Khmer (Ratree & Guinon, 2005; Kirby, 2014; Kirby & Đinh, 2017).

The glottal finals *-ʔ and *-h were not only reconstructed as the historical source of tones in Vietnamese, but also in other ESEA languages such as Chinese (Haudricourt, 1954a; Mei, 1970; Pulleyblank, 1978; Sagart, 1986, 1999), different Hmong-Mien languages (Ratliff, 2010), and Kra-Dai languages (Gedney, 1986; Norquest, 2007; Sagart, 2019). The generally accepted phonetic explanation for this type of tonogenesis is that the articulatory configuration of the glottal codas regressively inflects the f0 of preceding vowels by raising (*-ʔ) or lowering (*-h) it, leading to a rising or falling f0 contour. These f0 contours are then phonemicized when the segments are dropped (Haudricourt, 1954b). Moreover, it is generally accepted that these glottal finals conditioned other properties besides f0, like phonation type and duration (Egerod, 1971; Pulleyblank, 1978; Ferlus, 1979a; Sagart, 1999; Thurgood, 2002; Pittayaporn, 2009; Ratliff, 2010).

However, the effect of glottal codas on f0 might not be as cross-linguistically uniform as typically assumed. Final *-h and final *-s (there was a shift from *-s to *-h) are generally considered to have conditioned the development of falling tones, such as the departing tone (*qusheng*) in Chinese, tones *hỏi* and *ngã* in Vietnamese (reconstructed as falling tones by Haudricourt), and the low Tone 1 of Muak Sa'ak (Palaungic, Austroasiatic) (Hall, 2014). Final -h was also experimentally proved to have a f0-lowering effect in Arabic (Semitic) (Hombert, Ohala, & Ewan, 1979) and Balsas Nahuatl (Uto-Aztecan) (Guion, Amith, Doty, & Shport, 2010). However, the same final -h led to the development of a high tone in Tsat (Maddieson & Pang, 1993; Thurgood, 1993) and conditions a high f0 in the Chamic

(Austronesian) languages Raglai, Chru, Cham (Brunelle, pc.), the Chứt dialect Rục (Vietic) (Tạ, 2021), Thavung (Vietic) (Suwilai, 1996; Ferlus, 1998b), Jeh (Bahnaric, Austroasiatic) (Gradin, 1966). Likewise, the final glottal stop *-ʔ, which is regarded as the source of the Chinese rising tone (*shangsheng*) and Vietnamese tones *sắc* and *nặng* (proposed to be rising tones by Haudricourt), has an f0-lowering effect that gave rise to low tones in Tibetan (Mazaudon, 1976), Burmese (Bradley, 1982b), Kra-Dai languages (Gedney, 1986; Norquest, 2007; Sagart, 2019), and some Athabaskan languages (Kingston, 2005).

Haudricourt postulated that the neutralization of onset voicing in languages that already have tone causes a doubling of the tone inventory (Haudricourt, 1954b, 1965, 1972 [1961]). However, even in languages that are already tonal, the neutralization of voicing in onsets also seems to cause the development of secondary properties such as phonation and vowel quality differences in high (< *voiceless onsets) and low (<* voiced onsets) tones, for example, in Tamang (Tibeto-Burman) (Mazaudon & Michaud, 2008), Fuzhou Chinese (Donohue, 2017), Rục (Vietic) (Nguyễn, Trần, & Ferlus, 1988; Nguyễn, 1993; Solntsev et al., 2001a; Tạ, 2021), and the West Hmongic (Hmong-Mien) language Zongdi (Ratliff, 2010). These hybrid tonation systems have not appeared in many experimental studies, and as such, their phonetic mechanisms are not well understood. Nonetheless, their phonetic properties are the same as those involved in register (next section), making the distinction between tone and register languages extremely arbitrary (Haudricourt, 1965; Ferlus, 1979a; Bradley, 1982a; Ferlus, 1998b; Abramson & Luangthongkum, 2009).

1.1.2 Register and registrogenesis

Register in ESEA languages is usually a two-way contrast: in most cases, there are two

distinctive registers. Languages having more than two registers are extremely rare, but there is a four-way distinction in the Pearic language Chong (Huffman, 1985a; Thongkum, 1986; Edmondson, 1996; DiCanio, 2009). Different names have been used to refer to the two registers, but I will refer to them as the High Register and the Low Register. The two registers contrast in several phonetic properties, including (but not limited to) f0, phonation type, vowel quality, vowel duration, and VOT of onsets. Register languages differ in which phonetic cues are employed to signal the contrast and the magnitude of the chosen cues, making descriptions of register languages highly language-specific and even dialect-specific (Gregerson, 1976; Huffman, 1976; Ferlus, 1979a; Huffman, 1985b; Gehrmann, 2022). Generalizations have been made on the typical phonetic correlates of the two registers, which are given in Table 1-3.

Table 1-3. Possible phonetic correlates of registers (Brunelle & Kirby, 2016 : 193).

First register (= High register) (< *voiceless onsets)	***Second register (= Low register)*** (< *voiced onsets)
Higher pitch	Lower pitch
Tense/modal voice	Lax/breathy voice
Monophthongs/shorter vowels	Diphthongs/longer vowels
Raised F1/lower vowels/[+ATR]	Lowered F1/higher vowels/[-ATR]
Plain stops/shorter VOT	Aspirated stops/longer VOT

Figure 1-2 provides an example of register contrast in Chrau, a Bahnaric language (Austroasiatic), as produced by an older male speaker (data from Tạ, Brunelle, & Nguyễn, 2022). In this pair, /tiː/ ‘hand’ belongs to the high register (< *voiceless onset) and /t̪iː/ ‘weekday’ to the low register (< *voiced onset, the IPA symbol for devoicing is used to indicate the low-register onset). The low-register onset /t̪/ has a longer VOT than its high-

register counterpart /t/. There are also clear vocalic cues. First, f0 starts lower in the low than in the high register. The vowel onset also starts in a higher F1 and a lower F2 in the high register. In extreme cases, this on-gliding portion makes the vowel of the high register sound like [ᵊi:]. The fainter color in the high-frequency range of the low-register vowel also indicates a weaker relative intensity than in the high-register counterpart, suggesting a laxer/breathier phonation type.

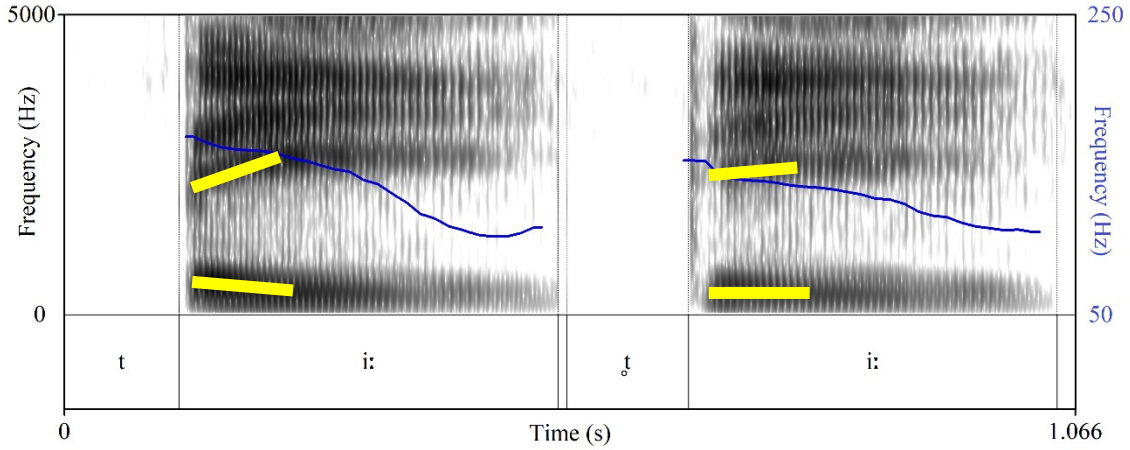


Figure 1-2. Spectrograms with overlaid f0 tracks (thin blue lines) of the minimal pair /ti:/ 'hand' and /t̥i:/ 'weekday' produced by an older male speaker of Chrau. Upper and lower bold yellow lines are the first and second formants, F1 and F2.

Registrogenesis, a term coined by Diffloth (1982) by analogy with tonogenesis, is used to refer to a process by which a language acquires a register contrast triggered by the loss of a voicing contrast on onsets. It has been claimed that registrogenesis can also develop out of a vowel height contrast (Diffloth, 1982; Sidwell, 2005; Gehrmann, 2015, 2022), but this type of registrogenesis (termed "heretic" registrogenesis by Diffloth) will not be addressed here, as there is no evidence that it ever occurred in Vietic, the focus of this dissertation (more in Chapter 2).

Registrogenesis derived from onset devoicing is a characteristic feature of the

Austroasiatic phylum (Henderson, 1952; Haudricourt, 1965; Huffman, 1976; Ferlus, 1979a), and it is attested in at least ten out of its 13 branches (§1.2.1). This type of register contrast is found in the Chamic family of the Austronesian phylum, in languages like Cham (Lee, 1977; Thurgood, 1996, 1999; Brunelle, 2005), Chru (Brunelle et al., 2020) and Northern Raglai (Brunelle et al., 2022a), and in Austronesian languages of Eastern Java like Javanese (Horne, 1974; Fagan, 1988; Hayward, 1993, 1995; Thurgood, 2004; Brunelle, 2010) and Madurese (Misnadin, 2016; Misnadin & Kirby, 2020). The phonetic explanation for registrogenesis from onset devoicing will be discussed in detail in Chapter 2, but it is generally attributed to the coarticulatory effects of several maneuvers used to initiate and maintain closure voicing in voiced onsets, such as larynx lowering, tongue root advancement, and tongue body lowering (Gregerson, 1976; Ferlus, 1979a; Thurgood, 2002).

1.1.3 Tonation

The relatedness between register and tone in Austroasiatic in terms of their shared phonetic properties (f0, phonation type, and vowel quality) and origin (onset devoicing) was pointed out fairly early (Haudricourt, 1965; Ferlus, 1979a). The fuzzy boundary (Abramson & Luangthongkum, 2009) between the two types of prosodic phenomena led researchers to use the term "tone" in its broadest sense to refer to the various realizations of tone and register (Ferlus, 1979a, 1998b) and encouraged others to build a unified framework describing and explaining register and tone patterns (Thurgood, 2002; Gehrmann, 2022). This is also why Bradley (1982a) proposed the term "tonation" to emphasize the presence of *phonation* and other register properties, like duration, intensity, and vowel quality, in ESEA *tone* systems. In this dissertation, I follow Bradley in adopting *tonation* as a cover term to refer to both tone and register.

1.2 Tonation systems in Austroasiatic and in Vietic

1.2.1 Tonation systems in Austroasiatic

The Austroasiatic phylum is the oldest recognized language phylum in Mainland Southeast Asia, a vast area stretching from South China, Myanmar, Thailand, Laos, Cambodia, and Vietnam to as far as peninsular Malaysia (Sidwell & Jenny, 2021, more in Chapter 3). Austroasiatic has a wide range of tonation systems that stemmed from various historical changes to its proto-sound system (Gehrmann, 2022).

First of all, many Austroasiatic languages are characterized by having a *register* contrast assumed to derive from the loss of the voicing contrast in proto-onset stops. It is phonetically realized on the adjacent vowel as differences in f0, phonation type, and vowel quality (Henderson, 1952; Shorto, 1962; Haudricourt, 1965; Huffman, 1976; Ferlus, 1979a; Brunelle & Kirby, 2016; Kirby & Brunelle, 2017). This onset-derived register contrast is attested in ten out of 13 established Austroasiatic branches; for each, I list one representative register language with selected references in Table 1-4. I am not aware of any register contrast reported in the three branches, Munda, Nicobarese, and Khasian.

Table 1-4. Representative languages with register contrast and selective references in the Austroasiatic phylum.

Family	*Language*	*References*
Monic	Mon	Shorto, 1962; Thongkum, 1987; Abramson, Tiede, & Luangthongkum, 2015
Khmeric	Khmer	Henderson, 1952; Jenner, 1974; Wayland & Jongman, 2003
Pearic	Chong	Huffman, 1985; Thongkum, 1986; DiCanio, 2009
Khmuic	Khmu	Premsrirat, 1999; Abramson, Nye, & Luangthongkum, 2007, Kirby, Pittayaporn, & Brunelle, 2023
Palaungic	Wa	Watkins, 2002
Bahnaric	Chrau	Tạ, Brunelle, & Nguyễn, 2019, 2022
Pakanic	Bugan	Jinfang, 1996
Aslian	Mah Meri	Stevens, Kruspe, & Hajek, 2006; Kruspe & Hajek, 2009
Vietic	Kri	Enfield & Diffloth, 2009

In some Austroasiatic languages, the same process of onset devoicing led to a two-tone contrast based on f0 height only and devoid of modulations of phonation type and vowel quality. Examples include several Khmu dialects (Svantesson, 1987, 1989; Premsrirat, 1999; Svantesson, 2001; Svantesson & House, 2006; Abramson, Nye, & Luangthongkum, 2007) and dialects of the two Palaungic languages Lamet (Mitani, 1965; Conver, 1999) and Blang/Samtao/Bulang (Diffloth, 1980; Svantesson, 1989)[4]. Two-tone systems based exclusively on phonation are also reported to derive from vowel height in the Palaungic language U (Svantesson, 1988, 1989) or vowel length in the Palaungic language Hu (Svantesson, 1989, 1991).

Although vowel-height-derived register contrasts exceed the scope of this dissertation, it is worth mentioning that these are attested in at least two Austroasiatic

[4] It is also attested in other languages in the world such as Afrikaans (West Germanic) (Coetzee et al., 2018) and Malagasy (< Malayo-Polynesian < Austronesian) (Howe, 2017).

branches, (North) Bahnaric (Smith, 1972) and Katuic (Diffloth, 2009; Gehrmann, 2015). In languages with this type of register, the contrast is usually between a tenser register (< *more open vowels) and a modal or laxer register (< *more closed vowels).

Another factor in the development of tonation in Austroasiatic is the loss of laryngeal contrasts in codas (§1.1.1). It is relatively rare outside Vietic, being attested in four Bahnaric languages, Jeh (Gradin, 1966), Todrah (Gregerson & Smith, 1973), Sedang (Smith, 1968; Smith, 1972), and Stieng (Bon, 2014), and in two Palaungic languages, U (Svantesson, 1987, 1988) and Muak Sa'ak (Hall, 2012), but is found in one form or another in the large majority of Vietic languages and will be discussed in more detail in the next section.

The four factors discussed above (onset voicing, vowel height, vowel length, and laryngeal codas) interact differently in different Austroasiatic languages and thus create a complex array of tonation systems in this language phylum. Readers are referred to Gehrmann (2022) for a thorough investigation and classification of tonation formation in Austroasiatic. I now move to the tonation systems in Vietic, the family of Austroasiatic that is the focus of this dissertation.

1.2.2 Tonation systems in Vietic

The Vietic family consists of nearly a dozen languages whose speakers mainly live in Vietnam and Laos, the more conservative languages being distributed around the Vietnam-Laos border in North-Central Vietnam (Ferlus, 1996). In terms of tonation, Vietic is almost as diverse as the Austroasiatic phylum (Alves, 2021). There are languages with a typical Austroasiatic register contrast, such as Arem (Đoàn, 1986; Trần, 1986; Ferlus, 2013) and Kri

(Enfield & Diffloth, 2009). Other Vietic languages have hybrid systems combining tone and register features, such as Maleng (Ferlus, 1997a, 1998b), Thavung (Ferlus, 1979b; Hayes, 1984; Suwilai, 1996), and the two Chứt dialects Rục and Mày (Nguyễn, 1993; Solntsev, Solntseva, & Samarina, 2001b; Babaev, Samarina, & Sidwell, 2021; Tạ, 2021). Still, tonation systems in other Vietic languages are primarily f0-based with little or no traces of register features, as in Pọong, Cuối (Ferlus, 1994b, 1998b, 2001; Nguyễn & Nguyễn, 2019), Mường (Nguyễn, 2005; Nguyễn, 2016, 2021), and Vietnamese (Thompson, 1965; Vũ, 1981; Edmondson & Lợi, 1997; Ferlus, 1998b; Pham, 2004). More details on Vietic tonation systems are presented in Chapter 3.

Given its diverse tonation systems, the study on Vietic can contribute to our understanding of the origin and development of the tonation systems of the Austroasiatic phylum in general. Indeed, Vietnamese is the language for which the first hypothesis on tone formation was proposed and later expanded to explain the development of tonation systems not only in ESEA but in other languages of the world (Haudricourt, 1954b, 1954a; Matisoff, 1973). In addition, descriptions of more conservative Vietic languages have allowed subsequent expansions and revisions of Haudricourt (1954b)'s initial hypothesis (Ferlus, 1979a, 1990; Alves, 1995; Ferlus, 1998b, 1999; Alves, 2003).

Except for those performed on Vietnamese, there are not many experimental studies on Vietic tonation systems, as researchers have mainly focused on the diachronic development of their contrastive tonation categories. This lack of experimental coverage arguably limits our understanding of the phonetic (articulatory and acoustic) motivation and mechanisms underlying tonation formation. In this dissertation, I attempt to partially fill this gap in the study of Vietic and Austroasiatic by providing experimental descriptions

of tonation in five Vietic varieties: Arem, Rục, and three North-Central Vietnamese dialects (§1.3). Along with a synthesis of the findings from previous studies, these empirical descriptions will allow me to propose new reconstructions of Proto-Vietic phonology and provide further refinements to hypotheses about the formation of tonation. In Chapter 7, I will propose that Proto-Vietic was already a register language, but that Vietic languages diverged in how their tonation system then evolved, especially in terms of how they preserved or lost glottal codas and channeled the evolution of their register cues.

1.3 The Vietic varieties studied in this dissertation

As mentioned above, Vietic has diverse tonation systems encompassing registral (Arem, Kri) to tonal (Vietnamese, Mường, Cuối), and hybrid systems combining tone and register features (Thavung, Maleng, Chứt, Pọong). Fine-grained phonetic investigations of these tonation systems can (i) bring us a better understanding of tonation in Austroasiatic as a whole, which in turn should allow (ii) better reconstructions of the proto-language and (iii) a better understanding of the phonetic motivations for the development of tonation in general. In order to achieve these aims, I study five Vietic varieties differing in their tonation systems in this dissertation: Arem, Rục (Chứt), and three North-Central Vietnamese dialects. Figure 1-3 illustrates the relative location of these Vietic varieties. They were chosen because they allow me to investigate the tonation systems of languages belonging to the most conservative group (Arem, Rục) and of varieties of the language diverging the most from canonical Austroasiatic languages (Vietnamese). Other Vietic languages spoken in Laos (Thavung, Maleng) seem to have interesting tonation systems

(more details in Chapter 3), but they could not be studied in this dissertation due to practical reasons, such as obtaining study permits from Laotian authorities and travelling restrictions during the pandemic.

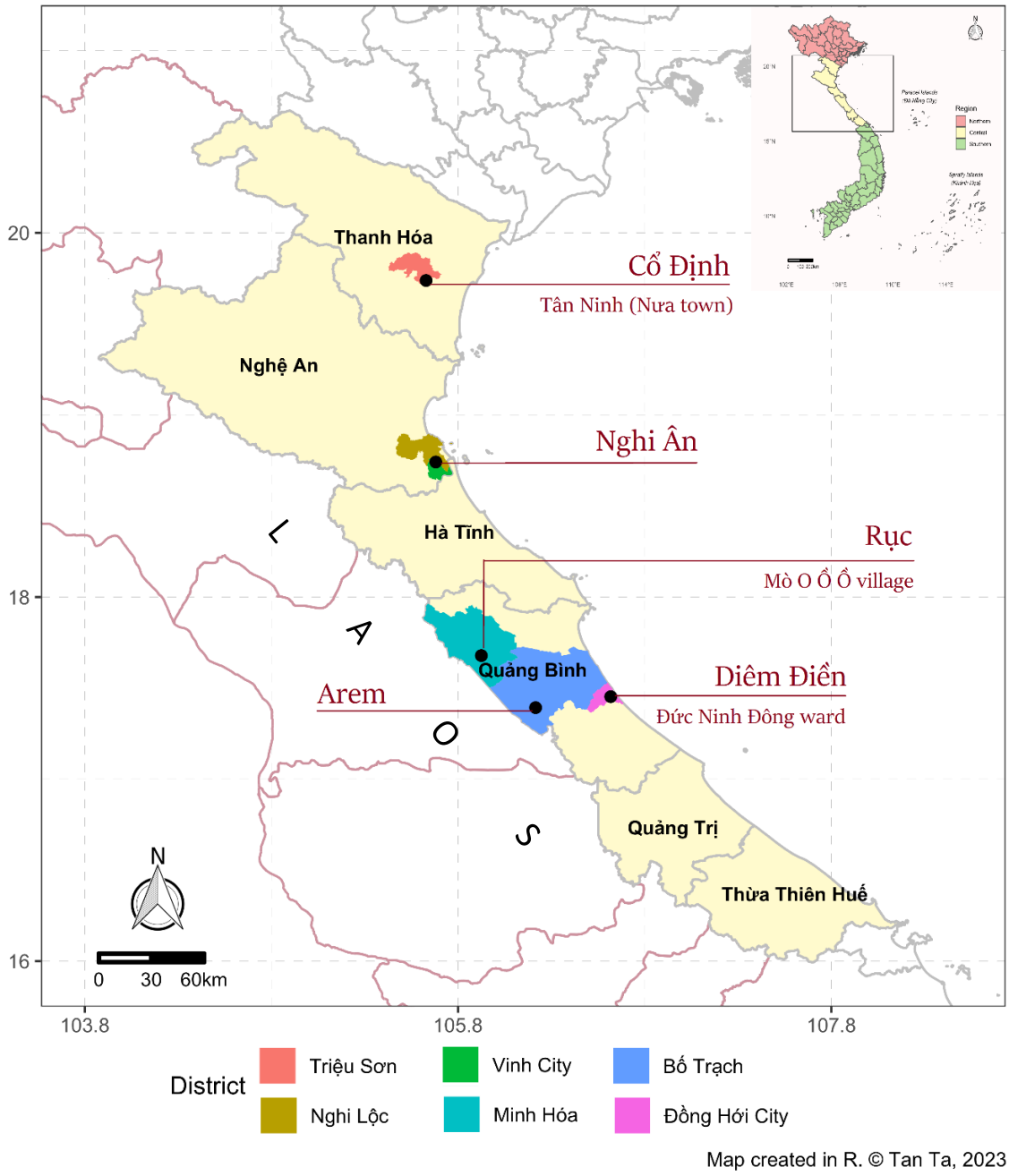


Figure 1-3. Five Vietic varieties studied in this dissertation.

1.3.1 Arem

Previous researchers have not reached a consensus on whether Arem is a tonal or registral or a hybrid tone-register language (Đoàn, 1986; Nguyễn, 1988; Trần, 1990; Kasuga, 1994; Ferlus, 2013). There are wordlists and recordings of the language, but no phonetic study of its tonation system is available. Since the language still preserves glottal finals -h, -ʔ, and other glottalized codas, it might be at an early stage of tonogenesis where the different effects of these codas on the preceding vowel provide seeds to the formation of tone contrasts. This is why Arem is a suitable language for studying phonetic precursors of tonogenesis. Moreover, Arem is a dying language with only seven speakers left. This study is a rare chance to record and preserve more data from the language before it disappears.

The data on Arem were obtained during two field trips to the community in the Quảng Bình province of north-central Vietnam in the summer of 2019 and the winter of 2021. I recorded a wordlist designed to investigate the Arem tonation system with five Arem speakers on the first trip. Audio, EGG (electroglottography), and larynx height tracking (LT) data were collected, and the audio data was archived on the Pangloss online archive at https://pangloss.cnrs.fr/corpus/Arem?lang=en. On the second trip, I recorded two other wordlists focusing on the effects of the glottal finals from four speakers. Only audio data was collected the second time.

The analysis of the Arem tonation system based on these data is in Chapter 4. The results show that Arem has a register contrast cued mainly by vowel quality and, to some extent, phonation type. F0 does not seem to play a role in the Arem register contrast. The final glottal -ʔ, -h, and glottalized sonorant codas affect the duration, f0 contour, and phonation type of preceding rhymes (vowels) in a variety of ways. Seeing as these glottal

codas are still well preserved in the language, and their effects are highly variable individually, I conclude that Arem cannot be treated as a language undergoing tonogenesis.

1.3.2 Rục

Rục, a Chứt dialect also spoken in the Quảng Bình province, has been described as a tonal language with four tones in open and sonorant-ending syllables. These tones emerged through the loss of the glottal stop -ʔ and the voicing contrast in onsets. They are distinctive in f0 height, f0 contour, and phonation type, and are accompanied by vowel changes (Trần, 1986; Nguyễn, 1993; Solntsev et al., 2001b; Tạ, 2021). Rục, therefore, seems to have a complex system of Austroasiatic tonation. Mày, another Chứt dialect, has been described as having the same tonation system as that of Rục (Babaev et al., 2021).

Rục has been treated as an important testbed in the study of Vietic because it preserves many archaic properties of the Vietic family, such as complex phonological word structures, morphological traits, and registral properties in its tonation system. The Proto-Vietic final fricative *-h is still preserved in Rục, which allows us to study its effect on preceding vowels in an already tonal language, but the status of this coda and its prosodic effects on preceding vowels have not been addressed in previous studies. Except for my initial phonetic analysis of the Rục tonation system (Tạ, 2021) and some phonetic results on the Mày tonation system (Babaev et al., 2021), the phonetics of Rục are still open for systemic investigation.

I made two field trips to a Rục community in the summer of 2019 and the winter of 2021, around the same time as the trips paid to the Arem community. On the first trip, I recorded 20 Rục speakers (ten men and ten women) as they produced a first wordlist that

focuses on the tonation system of the language. Audio, EGG, and LT data were collected. The audio data is available from the Pangloss project at https://pangloss.cnrs.fr/corpus/Rục?lang=en. On the second trip, I carried out a perception study with 39 Rục people to answer the question of which phonetic cues are used by Rục listeners to perceive their tonation contrasts. After the perception experiment, 13 participants also recorded a short wordlist designed to study the link between the production and perception of tonation. An additional 17 participants recorded a third wordlist focusing on the effect of the final fricative -h.

The analysis of audio and EGG data from the three recorded wordlists in Chapter 5 shows that Rục has a tonation system with four distinctive phonemes contrasting in a bundle of phonetic properties composed of f0 height, f0 contour, phonation type, and vowel quality. Therefore, Rục has a hybrid tonation system combining tone and register features and is an ideal language to study interactions between tonogenesis and registrogenesis. Moreover, the final fricative -h has peculiar effects on preceding vowels: it conditions a level and high f0 trajectory on preceding vowels, along with a tense but not creaky phonation at the vowel offset. This f0-raising effect of -h in Rục is the opposite of what has been reconstructed for Vietnamese and Chinese tonogenesis (Haudricourt, 1954b, 1954a). In chapter 7, I incorporate these first-hand findings with observations from other languages to revise Haudricourt (1954b)'s classic hypothesis on tonogenesis, specifically on the phonetic effects of glottal codas and their roles in tonogenesis. This revised model provides a more phonetically grounded account of tonogenesis and tonation patterns in Vietic languages and sheds light on their relation to tonogenetic mechanisms in other languages.

The results of the perception study in Chapter 5 indicate that Rục listeners use three

phonetic properties, vowel quality, f0, and phonation type, to perceive tonation contrasts. The perceptual weights of these cues differ between open and h-ending syllables and between listeners at the individual level. These results suggest a general match between production and perception of tonation and the flexibility of the two modes in individuals and the community.

1.3.3 North-Central Vietnamese dialects

Vietnamese is the language for which the first tonogenetic hypothesis was proposed (Haudricourt, 1954b). Despite numerous revisions and expansions of this original model, many issues remain unsettled. For example, is there any trace of register-conditioned vowel changes in the tonation systems of Vietnamese dialects as in other Vietic and Austroasiatic languages? How did the tones *hỏi-ngã* get their falling-rising contour from the falling pitch attributed to the final fricative -h? How and why do the original glottal codas -ʔ, -h have opposite effects on the tone systems in different languages and even dialects, and what are their consequences on our general understanding of tonogenesis? Did tonogenesis (from laryngeal codas) or registrogenesis (from onset voicing) occur first in Vietnamese and other Vietic languages? Is the breathy phonation occasionally found in the *huyền* tone in Northern dialects a remnant of an onset devoicing process, or is it just an automatic by-product of the tone being pronounced in a low pitch range, a mechanism attributed to the creakiness voice in Mandarin low-dipping tone (Kuang, 2013a)?

An important question that has been raised by diachronic linguists (without being fully explored) is the possibility that some apparently irregular vowel changes that occurred in Vietnamese are ultimately attributable to the neutralization of onset voicing and its effect

on the vowel quality. These vowel changes include diphthongizations of Proto-Vietic open vowels *ɛː > iə (e.g., *-lɛːmˀ > liəmʌ 'lick'), *ɔː > uə (e.g., *alɔːʔ > luəʌ 'paddy'), *aː > ɨə (e.g., *naːŋˀ > nɨəŋʌ 'grill'), and other vowel lowerings such as *uː > oː (e.g., *p-suːɲʔ > zoːnʌ 'navel'), *eː > ɛː (e.g., *meːʔ > mɛːꞌ 'mother'). Nguyễn (1995) claimed that these diphthongizations might be conditioned by lateral or nasal onsets, while Ferlus (1997b) maintained that these changes are irregular and independent of the register contrast. Nguyễn (2005) provided more instances of such vowel changes in Vietnamese and compared them to those found in its sister language Mường, without providing further explanation. The bottom line is that these changes seem relatively irregular in standard Vietnamese, perhaps because of dialect koinezation in the Red River delta over centuries.

In order to attempt to reconstruct the original form of Vietnamese tones at the stage where the earliest tonal contrast emerged and to look at the possible effect of voicing neutralization on the vowels of Vietnamese, I decided to look at Vietnamese dialects that are considered conservative because they are assumed to have branched out from other Vietnamese dialects early on and to have avoided convergence with standard Northern Vietnamese to the extent that other varieties have experienced.

The North-Central dialectal region, which subsumes four provinces, Thanh Hoá, Nghệ An, Hà Tĩnh, and Quảng Bình, is considered the most conservative in terms of its phonetics, phonology, and vocabulary (Nguyễn, 1995; Trần & Thái, 1998a; Hoàng, 2004; Alves & Hương, 2007). These North-Central dialects retain an archaic vowel system, with many vowel patterns similar to those found in other Vietic languages spoken in the same region. Researchers have carried out several studies on this vowel system (Nguyễn, 1995; Võ, 1997; Trần & Thái, 1998b; Hoàng, 2001b; Nguyễn, 2003; Hoàng, 2004; Nguyễn, 2005; Alves, 2007; Alves & Hương, 2007), but as far as I know, no data was available for open access until recently.

The tonation systems of the North-Central dialects are diverse, but available data suggest that they could be as conservative as their vowel systems. Unfortunately, previous studies only investigated modest numbers of participants (Pham, 2005; Phạm, 2019), or they even lumped together speakers of different dialects (Vũ, 1981; Honda, 2008). A systemic experimental study of these tonation systems could inform us as to the origin and development of tonation in Vietnamese and other Vietic languages.

Three representative dialects were chosen for this dissertation to study tonation and vowel systems in North-Central Vietnamese. Specific reasons for selecting each of these dialects are given below.

Cổ Định (Triệu Sơn district, Thanh Hoá province)

The dialect of Cổ Định in Thanh Hoá province is well known in the area and mass media for its distinct vocabulary, which itself reflects many archaic and peculiar properties of the vowel system. A study on this vowel system will provide evidence about the possible tonation-conditioned nature of some vowel changes.

This dialect also has a five-tone tonation system characteristic of Central and Southern dialects. From a historical perspective, Thanh Hoá and Nghệ An were the principal regions from which various waves of the population migrated toward the south when Vietnam gradually expanded southward. Therefore, a study on the tonation system of Cổ Định and other regional dialects could shed light on the evolution of tonation systems in South-Central and Southern dialects.

Nghi Ân (Vinh city, Nghệ An province)

The Nghi Ân dialect is well known in Nghệ An province because of its seemingly four-

tone system, but the phonetics of this tonation system has not been studied instrumentally. With a thorough description and analysis of this variety's tonation system, we can better position it among the systems of the region and deduce how these systems evolved from a common source. The dialect also retains a vocabulary layer with conservative vowels compared to Northern Vietnamese, which can help shed light on vowel changes in Vietnamese.

Diêm Điền (Đồng Hới city, Quảng Bình province)

Most ancestors of speakers of this dialect originated from the Thái Bình province in North Vietnam, but also from the Thanh Hoá province. They moved to Quảng Bình more than 400 years ago. This dialect is well known in the region and mass media because it has a peculiar tonation system where the relative heights of tones are not as expected. According to the classic tonogenetic hypothesis, tones derived from historically voiced onsets should have a lower f0 than those from historically voiceless onsets, but the Diêm Điền dialect has the opposite pattern. This situation may be the consequence of a tonation reversal (related to the notion of *tone flip-flop* (Wang, 1967; Yue-Hashimoto, 1986)) or may stem directly from peculiarities of the underlying tono-/registrogenetic procedures particular to this variety.

In the winter of 2021, I visited the three communities where these dialects are spoken to conduct a production study. A single wordlist was designed to investigate the tonation systems of the three dialects, with some adaptations as several lexical items differ between dialects. For each dialect, I recorded ten speakers (five men, five women) aged above 45. Only audio data was obtained. Another wordlist of more than 300 lexical items was recorded with at least two speakers in each dialect. These items contain archaic rhymes

that differ from those of standard Northern Vietnamese. The purpose of this second wordlist is to determine whether there are remnants of presumed tonation-conditioned vowel changes in standard Northern Vietnamese. The analysis of these data is laid out in Chapter 6.

The results show that two dialects, Cổ Định and Diêm Điềm, have creaky/tense phonation in their tonation systems. Both dialects also have a single reflex of Northern Vietnamese *hỏi-ngã*. Furthermore, the Diêm Điền dialect produces *huyền* and *nặng* with a higher f0 than *ngang* and *sắc* tones, respectively, patterns that are the opposite of what is found in almost all other Vietnamese dialects. The Nghi Ân dialect has four tones, and they do not seem to differ in phonation. These results illustrate the wide diversity of tonation systems in North-Central Vietnamese dialects. Evidence was found for tone-conditioned vowel changes in Cổ Định and Nghi Ân; however, these changes are not conditioned by the register contrast in the proto-language, but rather related to a tenser phonation caused by the low f0 range of specific tones.

In comparison with standard Northern Vietnamese, Cổ Định and Nghi Ân also have an older vowel system, which could be kept from Proto-Việt-Mường, the common ancestor of Vietnamese and Mường dialects. The results of the lexical comparison between Proto-Vietic and standard Northern Vietnamese confirm that the vowel changes observed in the latter (Nguyễn, 1995; Ferlus, 1997b; Alves & Hương, 2007) are mainly independent of register. Only two fairly consistent diachronic processes, *uː > oː, ɤw and *eː > ɤj, aːj in the context of high-register tones, could be considered tonation-conditioned vowel changes in Vietnamese. This means that if Vietnamese was once a register language, vowel quality did not play an important role in its register contrast.

1.4 Research questions

The aims of this dissertation are two-fold. First, I provide experimental descriptions of the tonation systems, and to some extent, vowel systems, in Arem, Rục, and three North-Central Vietnamese dialects. These new investigations into the tonation and vowel systems will be used to revise reconstructions of the tonation system and of other phonological properties of Proto-Vietic. Each chapter answers specific issues, but the dissertation as a whole attempts to tackle the following questions.

1. What is the phonetic realization of tonation in the five Vietic varieties under study? How do tone and register features interact in these languages?

1.1. What are the effects of glottal finals on the preceding vowel in languages preserving these segments?

a. What is the effect of -h in Rục, a Vietic language that still preserves it?

b. What are the effects of -h and -ʔ in Arem, a Vietic language that still preserves them? Do the effects of glottalized sonorant codas differ from those of -ʔ?

c. What are the remnants of *-ʔ and *-h in the tone systems of the three North-Central Vietnamese dialects at a fine-grained phonetic level?

1.2. What are the results of the presumed onset devoicing process in Vietic languages?

a. What are the registral properties in Rục, and what is the relative weight of each of these properties?

b. What are the registral properties in Arem, and what is the relative weight of each of these properties?

c. Is there any registral remnant of vowel quality and phonation type in the tone

systems of the Vietnamese dialects?

1.3. How do listeners perceive tonation contrasts in their language? (in Rục)

a. What are the perceptual cues of the tonation contrasts? How are these cues weighed in listeners' perception?

b. What is the link, if any, between the production and perception of tonation?

c. How do cue weighting strategies differ at the individual and group levels?

2. How can new experimental results from Vietic languages contribute to the reconstruction of Proto-Vietic tonation (and of its phonology in general)? How does this modify our understanding of tonogenesis and registrogenesis in ESEA languages?

2.1. What can the answers to the questions in **1** tell us about the effect of Proto-Vietic final laryngeals on tonogenesis?

2.2. How can the answers to the questions in **1** help us improve reconstructions of the Proto-Vietic tonation, vowel, and consonant systems?

2.3. What is the role of perception in tonogenesis and registrogenesis?

2.4. How does this new understanding of tonogenesis and registrogenesis in Vietic languages help us characterize and typologize tonation, and tonogenesis and registrogenesis in ESEA languages?

1.5 The structure of the dissertation

The rest of this dissertation is structured as follows.

In **Chapter 2**, I review the details of the laryngeal anatomy and the articulation mechanisms relevant to the production of tonation. Then, I provide definitions of tonation from the perspective of ESEA languages, and various models advanced to account for

tonation formation.

In **Chapter 3**, I provide an overview of the Vietic branch, its members and tonation systems. Previous reconstructions of the Proto-Vietic phonology are then presented. These reconstructions will be revisited in Chapter 7, based on the studies presented in Chapters 4-6.

Chapter 4 provides a production study of the tonation system of Arem, showing that it is a typical Austroasiatic register contrast mainly cued by vowel quality and, to some extent, phonation type. The effects of laryngeal finals in this language are also investigated to better understand tonogenetic mechanisms.

Chapter 5 includes production and perception studies of the tonation system of the Rục language. The results show that Rục has a tonation system with hybrid phonetic features of tone and register. The effect of the glottal coda -h is closely investigated as it helps to make significant revisions to tonogenetic hypotheses. I show that Rục is an important link between registrogenesis and tonogenesis.

In C**hapter 6**, I provide phonetic descriptions of the tonation systems of three North-Central Vietnamese dialects. I also devote a part of this chapter to addressing whether vowel changes in the standard Vietnamese are partly the results of registrogenesis.

General discussions on tone, register, tonogenesis, and registrogenesis in Vietic languages are provided in **Chapter 7**, along with revisions of reconstructions of Proto-Vietic. The main difference with previous work is that I propose a register distinction between a high and a low register in Proto-Vietic, from which descendant Vietic languages developed various tonation systems. Some concluding remarks end the Chapter, and the dissertation.

1.6 Contributions of the dissertation

This dissertation considers new findings that improve our understanding of the tonation systems and phonology of Vietic and Austroasiatic in general and contributes to the study of ESEA languages. These include:

1. Empirical descriptions of tonation systems in three Vietic languages: Arem, Rục, and Vietnamese (three dialects);
2. An evidence-based confirmation that registrogenesis did not leave traces of vowel quality changing in the tonation systems of Vietnamese dialects;
3. An updated typology of the effects of glottal codas in languages and dialects that explains different tonation developments and patterns within and across languages and language families in ESEA;
4. A new reconstruction of a register contrast between a high and a low register in Proto-Vietic;
5. Explanation for different patterns of tone correspondences between Old and Middle Chinese and Sino-Vietnamese vocabulary;
6. New data on several Vietic varieties that are already partially archived in an online and open-access language archive (Pangloss).

Chapter 2

Anatomical Basis and Development of Tonation

In this chapter, I first provide background information about some anatomical characteristics of the larynx relevant to the production of tonation in Section **2.1**. Then, I define the term *tone* and present different models put forth to explain the formation of tone, *tonogenesis*, in Section **2.2**. *Register* and models for the formation of register, *registrogenesis*, are discussed in Section **2.3**. The chapter ends with a discussion of the relative chronology between tonogenesis and registrogenesis in ESEA languages and the possibility of unifying these two processes in Section **2.4**.

2.1 The anatomical basis of tonation

As mentioned in Chapter 1, the main phonetic properties of tonation in ESEA languages in general, and in Vietic languages in particular, include modifications of f0, phonation types, and vowel quality. This section presents some basic anatomical components of the larynx

and their function in producing these properties of tonation. Special attention is paid to the aerodynamic voicing constraint (Ohala, 1983), which is claimed to be one of the most frequent precursors of the development of tonation in ESEA languages, and to different mechanisms that overcome this constraint along with their phonetic, mainly acoustic, consequences.

2.1.1 The larynx

The larynx, nontechnically called the "voice box," is situated between the hyoid bone and the trachea in the neck. Its structure comprises different pieces of cartilage and ligaments, muscles, and membranes connecting the cartilage (Gick, Wilson, & Derrick, 2013). The larynx forms a tube that houses the vocal folds, whose vibrations are the source of voiced sounds. Figure 2-1 provides anterior, lateral, and posterior views of the principal cartilage formations composing the larynx.

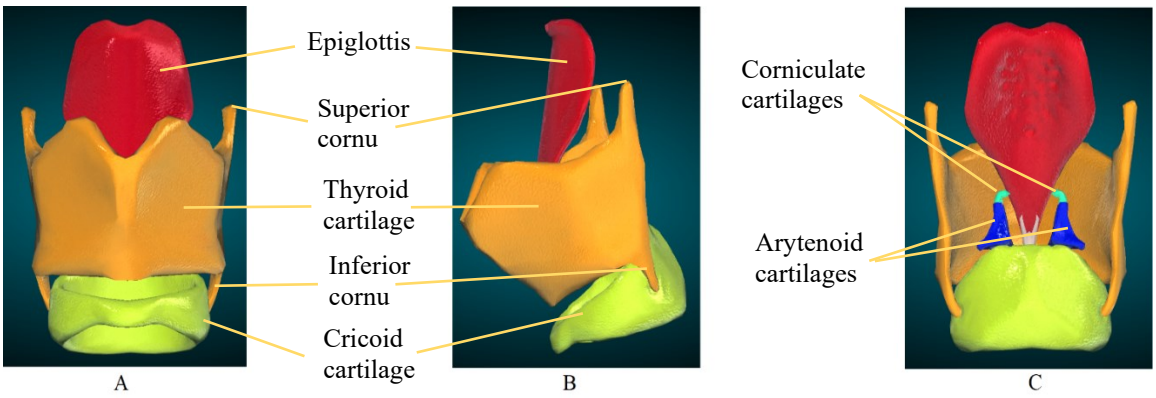


Figure 2-1. Anterior (A), lateral (B), and posterior (C) views of the principal cartilages of the larynx. Retrieved from anatomylearning.com, 09/19/2022.

The *cricoid cartilage* is a signet-shaped ring that lies at the bottom of the larynx, right above the trachea. Its front part is an arch, and its back part is composed of two

laminae. On the top of the two laminae are two facets for articulation with arytenoid cartilages.

The *thyroid cartilage* sits above the cricoid cartilage. It is composed of two laminae which fuse anteriorly. The point where they meet forms a protrusion called the *laryngeal prominence*, which is more acute and protruding in men than women and is commonly known as the *Adam's apple*. The two laminae do not close posteriorly but protrude upward and downward, forming the superior and inferior cornua. The two inferior cornua sit on the cricoid cartilage at the facets where the front arches and the back laminae of the cricoid cartilages meet.

Two *arytenoid cartilages* articulate on the top of the cricoid cartilage. The arytenoid cartilages are pyramid-shaped, and their apices articulate with two *corniculate cartilages*. The base of arytenoid cartilage protrudes anteriorly and lateroposteriorly to form vocal and muscle processes, respectively. The *epiglottis* attaches to the inner surface of the laryngeal prominence via the thyroepiglottic ligament.

Some relevant membranes and ligaments of the larynx connecting the cartilaginous structures of the larynx are illustrated in Figure 2-2.

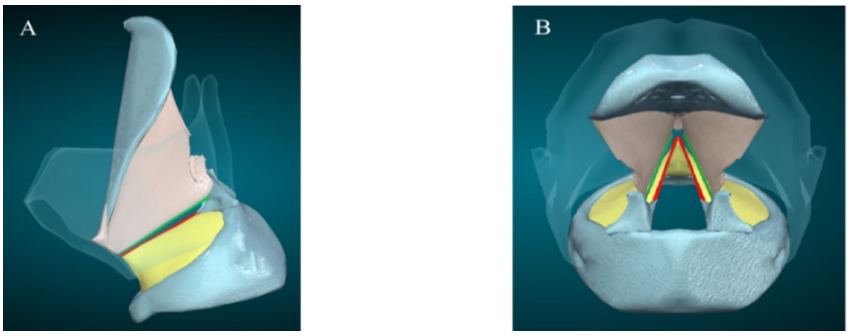


Figure 2-2. Lateral (A) and aerial posterior (B) views of the larynx membrane, ligaments, and muscles: *quadrangular membrane* (beige), *cricovocal membrane* (yellow), *vocal ligaments* (red), and *cricothyroid muscle* (green). Retrieved from anatomylearning.com, 09/19/2022.

The *quadrangular membrane* extends from the sides of the epiglottis to the arytenoid cartilages. It attaches anteriorly to the inferior surface of the thyroid cartilage and posteriorly to the upper half of the lateral side up to the apex of the arytenoid cartilage and the corniculate cartilage. Its low edge is free and thickens to form the *vestibular ligaments*, also known as the *false vocal folds*.

The *cricovocal membrane* (also *conus elasticus*) starts from the upper edge of the cricoid cartilage arch. It extends upward and medially, attaching anteriorly to the inferior surface of the thyroid cartilage and posteriorly to the vocal process of the arytenoid cartilages. The upper free edge of this membrane thickens to form the *vocal ligaments* (thyroarytenoid ligaments). The mucous membrane over the vocal ligaments forms the *vocal folds* (vocal cords). The vibration of the two vocal folds is the source of voiced sounds.

The opening between the vocal folds is the *rima glottidis*, whose more common name is the *glottis*. The frequency (f0) of vibration of the vocal folds depends on their length and thickness, two properties that are modulated by several groups of laryngeal muscles.

The *cricothyroid muscle* stems from the outer surface of the cricoid cartilage arch (Figure 2-3). It extends up and backwards and enters into the inner surface of the inferior cornua and the lower edge of the thyroid lamina. When this muscle contracts, it tilts the thyroid cartilage forward and downward, lengthening and tensing the vocal folds and, therefore, increasing f0.

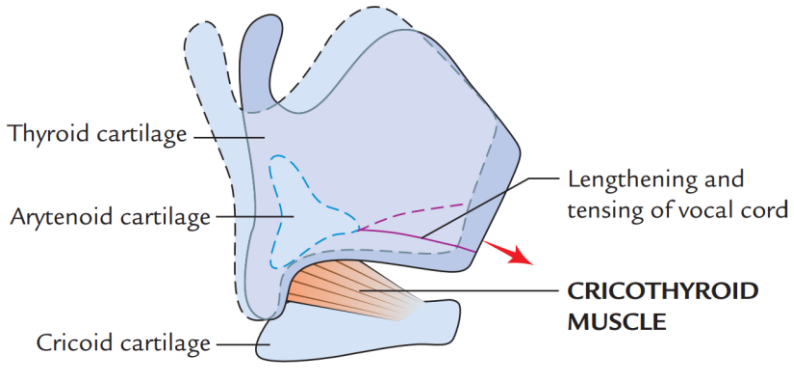


Figure 2-3. The action of the *cricothyroid* muscle to lengthen and contract the vocal folds, raising the fundamental frequency (f0). Image from (Singh, 2014).

The *thyroarytenoid* and *vocalis* muscles both start from the inferior surface of the thyroid angle (Figure 2-4). The former attaches to the anterolateral surface of the arytenoid cartilage, and the latter to the lateral surface of the vocal process. The vocalis muscle runs parallel and laterally to the vocal ligament.

When the thyroarytenoid muscles is set in contraction, it shortens and relaxes the vocal fold, decreasing f0. The effect of the contracted vocalis muscle is more complex: it tenses the vocal folds anteriorly and relaxes them posteriorly, making fine adjustments to the rate of vibration of the vocal folds.

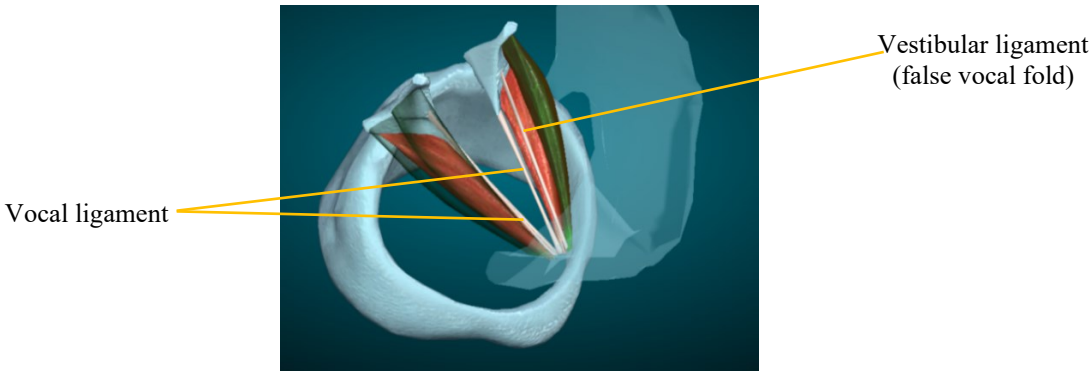


Figure 2-4. Aerial-lateral view of the *thyroarytenoid* (green) and *vocalis* (red) muscles. The section of the thyroid cartilage and the right-side thyroarytenoid muscles were made transparent. Retrieved from anatomylearning.com, 09/19/2022.

Phonation type largely depends on the degree and the location of glottal opening. Phonation type adjustments are modulated by groups of **adductor** (closing) muscles, including the *transverse* and *oblique arytenoid* muscles and *lateral cricoarytenoid* muscles. The only **abductor** (opening) is the *posterior cricoarytenoid* muscle. Except for the transverse arytenoid muscle, the other three are paired muscles. The origin and attachment of these muscles are given in Table 2-1, and their functions are illustrated in Figure 2-5.

Table 2-1. Abductor and adductor muscles of the larynx.

	Name	***Origin***	***Insertion***
Abductor	Posterior cricoarytenoid	Posterior surface of cricoid lamina	Back of the vocal process of arytenoid cartilage
Adductor	Lateral cricoarytenoid	The lateral part of the superior surface of the cricoid arch	Front of the vocal process of the arytenoid cartilage
	Transverse arytenoid	The posterior surface of one arytenoid cartilage	The posterior surface of another arytenoid cartilage
	Oblique arytenoid	The muscle process of one arytenoid cartilage	The apex of the other arytenoid cartilage

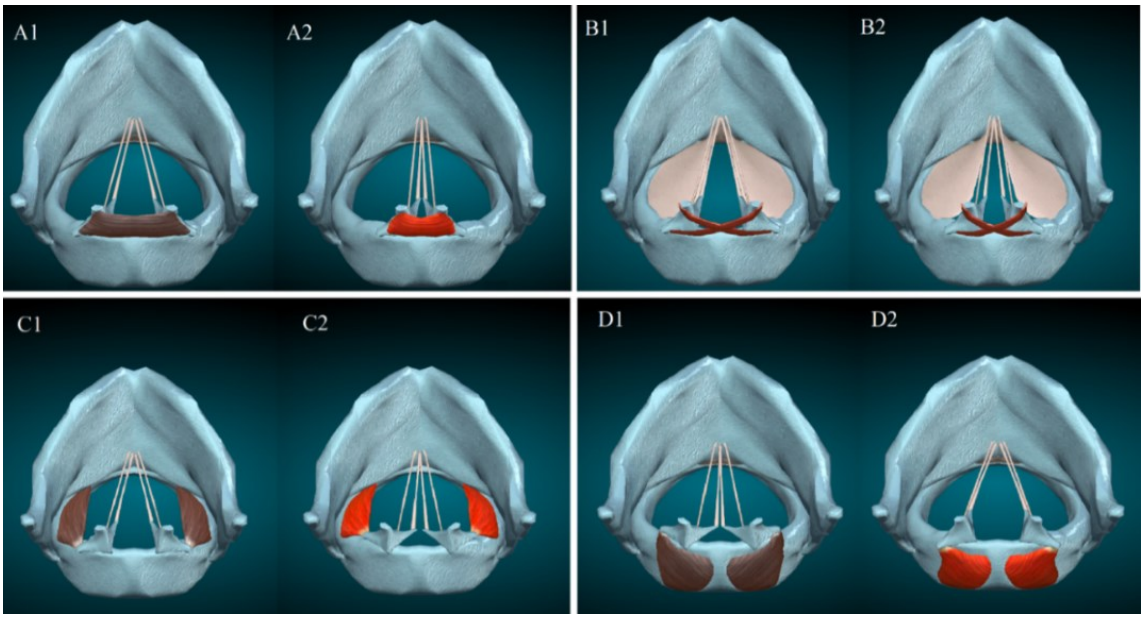


Figure 2-5. The effects of the contraction of the *transverse arytenoid* (A1, A2), *oblique arytenoid* (B1, B2), *lateral cricoarytenoid* (C1, C2) and *posterior cricoarytenoid* muscles (D1, D2). The contracted muscles are in bright red (A2, B2, C2, and D2). While contraction of A, B and C adducts the glottis and shortens the vocal folds, the contraction of D abducts the glottis and lengthens the folds. Retrieved from anatomylearning.com, 09/19/2022.

2.1.2 Aerodynamic Voicing Constraint

Closure voicing is articulatorily disfavoured in voiced stops because of the Aerodynamic Voicing Constraint (AVC) (Ohala, 1983). To produce voicing, the vocal folds must be adducted to the right degree so that they can be set into vibration when the air from the lungs flows continuously through the glottis. This airflow can only be maintained when the pressure difference between the sub- and supra-glottal cavities, the *transglottal air pressure*, is sufficient. In voiced stops, the complete closure in the oral cavity (and the raising of the velum to block the nasal cavity) prevents the air from escaping, raising the supraglottal pressure. This leads to a drop in transglottal pressure and if no additional articulation maneuver is performed, the consequent interruption of voicing. The AVC also constrains the production of voiced fricatives, even if their oral closure is partial.

This constraint likely explains why voiced obstruents are typologically marked and often devoiced, especially utterance-initially. Variability in the closure voicing of voiced stops is studied most extensively in English (see Davidson (2016) for a recent systematic study). In this language, voiced stops are normally partially or fully devoiced word-initially, and the voicing contrast between voiced and voiceless stops is normally realized phonetically as a distinction between short lag and long lag VOT. Word-medially, the proportion of voiced stops with full closure voicing is higher but does not exceed 50% (Davidson, 2016).

As closure voicing is essential to maintain voicing contrast between voiced and voiceless stops in many languages such as French, Italian, and Portuguese, specific languages and even individual speakers might employ several additional articulatory maneuvers to overcome the AVC by decreasing the supraglottal pressure. Reported maneuvers include oral and nasal leakage, tongue root advancement, tongue body lowering, and larynx lowering (Bell-Berti, 1975; Westbury, 1983; Westbury & Keating, 1986; Solé, 2012; Ahn, 2018a, 2018b; Solé, 2018).

The first two maneuvers let some air escape the supraglottal cavity, decreasing its pressure and ensuring that transglottal pressure is sufficient to maintain vocal fold vibration. When nasal leakage reaches a certain point, the voiced stop is prenasalized, for example, b > ^{m}b. The prenasalization of word-initially voiced stops is attested in ESEA languages like Jruq (Austroasiatic) (Jacq, 2002), Sui (Kra-Dai) (Wang, 1988), and Geman (Tibeto-Burman) (Namkung, 1996) and elsewhere (Solé, 2012). However, as it has not been described or reconstructed in Vietic languages, I will not delve into this topic further.

Tongue root advancement, tongue body lowering, and larynx lowering all aim to increase the supraglottal cavity's volume, reducing its pressure so that transglottal airflow and vocal fold vibration can be maintained longer. Larynx lowering and tongue root

advancement have been explicitly proposed as precursors of the register contrast in ESEA languages (Gregerson, 1976; Huffman, 1976; Ferlus, 1979a), and I will discuss their articulatory consequences in more detail in the next section.

2.1.3 Expanding the supraglottal cavity and its consequences

The mechanisms used for expanding the supraglottal cavity in voiced stops, like larynx lowering, tongue root advancement, and tongue body lowering, can cause modifications to the following vowel, including vowel quality, f0, and voice quality. As these modifications are instrumental to the development of tone and register, they are reviewed below.

2.1.3.1 Vowel quality

When the larynx moves downwards, the back cavity is lengthened, causing the first formant F1 to decrease[5]. This lower F1 has been claimed to perceptually distinguish voiced stops from their voiceless counterparts (Stevens & Klatt, 1974; Esposito, 2002; Kingston, Diehl, Kirk, & Castleman, 2008). F2 also seems to be higher after voiced than voiceless onsets (Sussman & Shore, 1996; Modarresi, Sussman, Lindblom, & Burlingame, 2005), but this could only be explained if maneuvers other than larynx lowering are considered. For example, tongue root advancement both enlarges the pharyngeal cavity, which in turn lowers F1, and reduces the front cavity volume, which raises F2 (Rothenberg, 1966; Kent & Moll, 1969; Westbury, 1983). Together, these F1 and F2 changes result in vowel raising (closing) and fronting after voiced stops.

[5] For non-high vowels, the lengths of the back and front cavities relative to the constriction place determine the value of the first and second formant, F1 and F2, respectively, according to the formula: $F = \frac{c}{4l}$ where c is the speed of sound (35,000 cm/s), and l is the length of the back cavity (F1) and front cavity (F2).

For high vowels such as /i u/, F1 is the Helmholtz frequency, which also depends on the volume of the back cavity, although to a lesser extent than in non-high vowels[6]. Therefore, when the back cavity is lengthened and expanded by articulatory maneuvers to overcome the AVC, the effect of lowering F1 is more negligible in high than non-high vowels (Esposito, 2002; Brunelle & Tạ, 2021). F2, on the other hand, corresponds to the resonance frequency of the back cavity in the front vowel /i/ and of the front cavity in the back vowel /u/ (more detailed explanation in (Johnson, 2011)). This means that pharyngeal expansion lowers the F2 of front vowels like /i/, while back vowels like /u/ should not be notably affected.

2.1.3.2 F0

It has long been known that the larynx tends to be lowered when producing a lower f0 (Curry, 1937; Chiba & Kajiyama, 1958; Ewan & Krones, 1974; Gandour & Maddieson, 1976; Kakita & Hiki, 1976), but how this vertical movement of the larynx affects muscles and ligaments that modulate the length and tension of the vocal folds remained unclear until the publication of Honda, Hirai, Masaki and Shimada (1999).

According to Honda et al. (1999), the larynx is located at the level of the neck where the cervical spine displays an anterior convexity (lordosis). When the larynx moves downwards along the cervical lordosis, the cricoid cartilage is rotated accordingly, with the cricoid arch (anterior part) showing a broader movement, as illustrated in Figure 2-6. The cricoid plate (posterior aspect) and the two arytenoid cartilages are therefore rocked

[6] The Helmholtz frequency is calculated by the formula $f = \frac{c}{2\pi}\sqrt{\frac{A_c}{A_b\, l_b\, l_c}}$ where c is the speed of sound (35,000 cm/s), and A and l are respectively the cross-sectional area and the length of the constriction ($_c$) and the back cavity ($_b$).

forward. As a result, the vocal folds (shorter horizontal line in the rightmost image of Figure 2-6) are shortened and relaxed, leading to a lower pitch. The same study showed that larynx height is more stable in the high than the low f0 range. This suggests that the downward movement of the larynx is more likely to lower f0 than its upward movement to raise it.

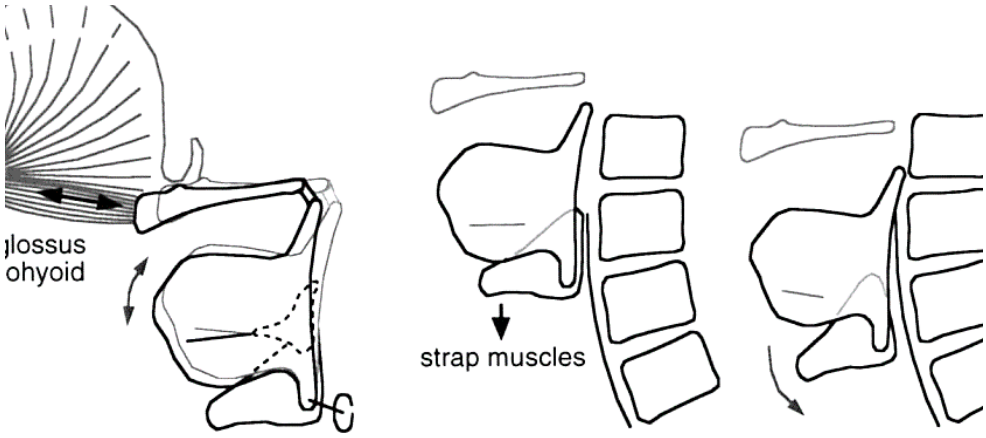


Figure 2-6. Vertical movement of the larynx and its effect of f0 lowering (plate (b)). Reproduced from Honda et al. (1999, p. 407).

2.1.3.3 Phonation

The relation between the maneuvers employed to overcome the AVC and phonation types is not as well-understood as that between the maneuvers and vowel quality and f0, and the literature on the issue is scarce.

Ferlus (1979a) suggested that the loosening of the vocal folds caused by the downward movement of the larynx allows for a greater amount of air to flow through the glottis, making the following vowel breathier, at least for its onset. This explanation is echoed in Brunelle (2005, p. 157), where the author attributed the cause of the higher airflow to the higher transglottal pressure caused directly by the lowering of the larynx.

Gregerson (1976) attributed the phonation difference associated with Austroasiatic registers (and, more radically, closure voicing itself) to tongue root advancement/retraction (more details in §2.3.2). However, he also acknowledged that lowering the larynx is "a natural, but independent and optional coarticulation with advanced tongue root position" in creating a larger pharyngeal cavity in the Low register (1976, p. 338). The expanded pharyngeal cavity gives an impression of "deep" sounds in the Low register. Gregerson's "deep" pharyngeal sound was not phonetically well-defined, and his tongue root movement hypothesis would not suffice to explain phonation differences.

Recently, Brunelle et al. (2022a), in their study on two Raglai (Chamic, Austronesian) dialects, suggest that phonation effects on the following vowel might not be a secondary cue of closure voicing but instead a consequence of the devoicing of the onset. In their data from the Northern Raglai dialect, voiced stops have a variant with a "voiceless release": closure voicing is still present but is interrupted several milliseconds before the release (burst), which is followed by a short lag VOT. It is the lag VOT that conditions a breathier voice quality on the following vowel. This lag VOT (voiceless release) seems to be the precursor of a longer VOT in the Low than the High register observed in numerous register languages of ESEA (Huffman, 1976; Brunelle & Kirby, 2016; Brunelle, Tạ, & Kirby, 2019; Brunelle et al., 2020; Tạ, 2021; Tạ et al., 2022). The discovery of this voiced stop variant could be considered the first empirical evidence for the claim that phonation is the primary cue at the early stages of registrogenesis, even if the presence of other cues is not ruled out (Haudricourt, 1965; Huffman, 1976; Ferlus, 1979a; Thurgood, 2002; Wayland & Jongman, 2002). This aspiration-induced phonation perturbation is in line with the cross-linguistic observation that aspirated onsets always induce a higher degree of breathiness on the

following vowel than both voiced and plain voiceless ones (Gobl & Chasaide, 1988; Löfqvist & McGowan, 1992; Ren, 1992; Chen, 2011); but variation in f0 and vowel quality of aspiration in these languages is important and does not always coincide with what is found in the register languages of ESEA. Brunelle et al. (2022a) also show that women exhibit the voiceless release more frequently than men. According to them, the fact that women often have a posterior glottal opening even when they try to fully adduct the glottis would favour the presence of a noisy air leakage when they produce voicing, causing a breathier phonation on the following vowel. It is unclear, however, how this devoicing-conditioned breathy phonation extends from women to men.

2.2 Tone and tonogenesis

2.2.1 Definitions of tone

Hyman (2001) defines a tone language as follows:

> "A language with tone as one in which an indication of pitch enters into the lexical realization of at least some morphemes." (2001, p. 1367)

This definition sketches out tone as a phonological unit whose phonetic basis is "an indication of pitch," meaning the perceived relative height and contour of the fundamental frequency (f0), and whose function is to change the lexical meaning of morphemes in the language in question. This definition of tone as a lexical property is meant to exclude the role of pitch in focus, pragmatics, and other intonational contexts, where pitch differences add nuances to contextual meanings but not the core meaning of the morphemes (Pierrehumbert, 1980; Selkirk, 1980; Selkirk, 1984). The phrase "at least some morphemes"

allows the definition to include not only full-fledged tone languages such as Thai, Chinese, and Vietnamese, where every syllable (morpheme) must bear a tone but also languages with sparser or accent-like tone, the so-called "pitch-accent" languages, such as Japanese. ESEA register is not considered in Hyman's definition of tone.

Although this is not mentioned in Hyman's definition, tone is usually treated as a suprasegmental unit. The suprasegmentality of tone is treated most explicitly in autosegmental phonology (Goldsmith, 1990), where tone representation is represented in a tier distinct from those of segments (vowels, consonants) and is associated with the segmental tier by association conventions. Not all tone languages require complex association rules. In Vietnamese, for instance, tones are always realized on the syllable to which they are lexically associated.

Although few authors explicitly rule out the possibility that tone includes other phonetic properties, most mainstream definitions of tone mention pitch (f0) as the only, or at least the most prominent, property of tone. For example, Yip defines a tone language as one where "the pitch of the word can change the meaning of the word" (2002, p. 1); Crystal considers tone the "distinctive pitch level of a syllable" (2008, p. 486). However, recent work has shown that tone often includes properties other than pitch, like phonation modulations, duration, and even vowel quality (Edmondson & Lợi, 1997; Pham, 2004; Ratliff, 2010; Kuang, 2013b; Brunelle & Kirby, 2016; Donohue, 2017; Kirby & Brunelle, 2017).

Hyman's definition of tone is still indirect as it defines "tone language" but not tone *per se*. From what has been discussed on tone, I propose a slightly modified version as follows, with a focus put on lexical tone rather than intonational or grammatical tone:

> *Lexical tone is a phonological unit whose most prominent phonetic characteristic is f0 and whose function is to encode the meaning of a morpheme.*

2.2.2 Tonogenesis and tonogenetic models

2.2.2.1 Tonogenesis

The term *tonogenesis* was coined by Matisoff (1970) to explain the emergence of the high-rising tone in Lahu, a Lolo-Burmese language, resulting from the dissimilation of two strong glottal constrictions (initial syllable's onset glottal stop *ʔ- and voiceless codas *-p/t/k of the second syllable in the same word in proto-Lolo-Burmese). In fact, the term was originally used as an adjective (*tonogenetic*). However, tonogenetic mechanisms were explicitly demonstrated by Haudricourt (1954b) when he proposed the first account of the development of tones from laryngeal properties of codas and onsets in Northern Vietnamese. By doing so, he also confirmed the linguistic affiliation of Vietnamese as an Austroasiatic, rather than Kra-Dai or Tibeto-Burman language, a matter that was still debated at the time (Maspero, 1912; Haudricourt, 1954b).

Following Matisoff (1973), *tonogenesis* was widely adopted to refer to *any* process by which an atonal language becomes tonal. The main sources of tonogenesis are the loss of final laryngeals, the neutralization of onset voicing, and, much more rarely, the neutralization of vowel length and quality (more details below). Tonogenesis is reconstructed in all five language families of Southeast Asia (Haudricourt, 1954a; Matisoff, 1973; Erickson, 1975; Gedney, 1986; Gedney, 1989; Ratliff, 2010), but it has also been experimentally studied in geographically distant and genetically unrelated languages such as Seoul Korean (Silva, 2006; Kang & Han, 2013; Bang et al., 2018), Afrikaans (Coetzee et al., 2018), Balsas Nahuatl (Guion et al., 2010), and Malagasy (Howe, 2017).

In the next section, I present the classical tonogenesis hypothesis formulated by Haudricourt (1954b) and subsequent modifications of his theory by other researchers. The

section, therefore, mainly focuses on tonogenesis in Vietnamese, both because it is the language for which the first model of tonogenesis was developed and because Vietic is the subject of this dissertation.

2.2.2.2 Models of tonogenesis, with a focus on Vietnamese

a. Haudricourt's (1954b) tonogenetic hypothesis

It must be recognized that Maspero (1912) made important observations that were later modified and developed by Haudricourt (1954b) to form the first tonogenetic hypothesis. Firstly, Maspero found correspondences between voiced initials and low-tone realizations, and voiceless initials and high-tone realizations both in Middle Chinese (1912, pp. 88-89) and in Sino-Vietnamese (hereafter SV), the layer of the Vietnamese lexicon composed of Chinese loanwords (1912, pp. 95-96). Secondly, Maspero found regular tonal parallels between Vietnamese and Siamese (Kra-Dai), to which Haudricourt (1954b) later added Middle Chinese (hereafter MC): Vietnamese *ngang-huyền* ~ Siamese *unmarked* tone ~ MC *pingsheng* (level tone); Vietnamese *sắc-nặng* ~ Siamese *mai tho* ~ MC *shangsheng* (rising tone); Vietnamese *hỏi-ngã* ~ Siamese *mai ek* ~ MC *qusheng* (falling tone); and Vietnamese checked *sắc-nặng* ~ MC *rusheng* (entering tone). However, Maspero assumed that the three languages were originally tonal and proposed no segmental origin for tones. He partly based himself on these tonal patterns to classify Vietnamese as belonging to the Tai family (Kra-Dai phylum). Lasty, Maspero uncovered that Austroasiatic words ending in -h (and -s) correspond to *hỏi* and *ngã* tones, and sometimes the *nặng* tone, although he wrongly considered them as loanwords into Vietnamese rather than cognates.

These three observations, along with the question of the origin of three Vietnamese

tone pairs (*ngang-huyền, sắc-nặng,* and *hỏi-ngã*) were picked up and reinvestigated by Haudricourt (1954b), resulting in the first hypothesis on the development of tones from segmental properties. Here, Haudricourt's crucial and ground-breaking contribution to linguistics in general, and the study of tone in particular, is the finding that tones are traceable to pitch modifications in vowels caused by the presence or absence of specific classes of consonant onsets and codas. The general tonogenetic scenario proposed by Haudricourt was already described in Chapter 1, §1.1.1, but we will go over it in more detail here.

Haudricourt argued that Vietnamese first developed two primordial tones from the loss of the laryngeal codas -ʔ and -h, in contrast with an unmarked tone in originally open syllables. Each of these three primordial tones was later split into two because of the neutralization of voicing contrast in onsets. These tonogenetic processes arise because of the production of laryngeal codas and onset voicing involves modifications of f0 on adjacent vowels, which are instrumental to the formation of tone.

The first clue about the origin of *hỏi* and *ngã* tones had already been uncovered by Maspero (1912, pp. 100-103) when he compared Vietnamese with other Austroasiatic languages and found correspondences between (i) Vietnamese *hỏi* tones and words with final -h (< *s)[7] and voiceless onsets in Austroasiatic (for example, 'seven' Vietnamese *bảy*, Mon *tă-păh*, Stieng *póh*, Bahnar *tơ-pơh*; 'break' Vietnamese *bẻ*, Mon *lă-păh*, Khmer *bèh*), and (ii) *ngã* tone and words with final -h (< *s) and voiced onsets (for example, 'nose' Vietnamese *mũi*, Moin *mŭh*, Khmer *cre-múh*, Stieng *tre-múh*, Bahnar mŭh, Rơngao *muh;*

[7] It is common in Austroasiatic, and especially Vietic languages, for the final fricative -s to mutate and merge to the final laryngeal -h, probably through chain shifts of -s > -j^{h} -l^{h} -r^{h} > -h (Nguyễn, 1993; Ferlus, 1998b; Solntsev et al., 2001b; Ferlus, 2004, 2014; Babaev et al., 2021).

'root' Vietnamese *rễ*, Mon *rơh*, Khmer *ris*, Stieng *ri^{e}h*, Bahnar *riơh*/*rơh*, Rơngao *e-rih*)[8]. From these correspondences, Haudricourt argued that the loss of the final -h in the proto-language gave rise to *hỏi* and *ngã* tones in Vietnamese. His phonetic explanation for the change is as follows:

> "The final fricative became a laryngeal -h produced by an abrupt slackening of the larynx. The slackening of the vocal folds produced a drop in the pitch of the preceding vowel, i.e. a falling tone." (Marc Brunelle's translation, Haudricourt, 2018, p. 15)

Similarly, Haudricourt argued that the Vietnamese *sắc* and *nặng* tones were derived from the final glottal stop -ʔ in the proto-language, which is still preserved in other Austroasiatic languages. Here are some examples provided by the author: 'leaf' Vietnamese *lá*, Riang *la*ʔ, Khmu *l̥aʔ*; 'rice' Vietnamese *gạo*, Riang *koʔ*, Khmu *rənkoʔ*; 'fish' Vietnamese *cá*, Riang, Khmu *kaʔ*; 'dog' Vietnamese *chó*, Riang, Khmu *soʔ*; and 'louse' Vietnamese *chí*, Riang *siʔ*. The explanation for the change from -ʔ into *sắc/nặng* tones is as follows:

> "A glottal stop following a vowel is produced by an increase in vocal fold tension (the opposite of what we have seen for final -h). During the articulation of the vowel, the increase in vocal fold tension in anticipation of the coda glottal stop produces a rising tone. This tone, a phonetic consequence of the glottal stop, becomes a truly phonological tone used to distinguish the word when the glottal stop disappears." (Marc Brunelle's translation, Haudricourt, 2018, p. 16)

However, Haudricourt admitted that unlike the case of *hỏi/ngã* tones and the final

[8] More cognates with Vietnamese *hỏi-ngã* tones and the final -h in other Mon-Khmer languages were added later in Gregerson and Thomas (1976).

fricative -h, the correspondence between *sắc/nặng* tones and the final glottal stop -ʔ is not perfectly regular: *sắc*-bearing words ending in sonorants do not have the expected -ʔ in Palaung-Wa (Austroasiatic) cognates. In fact, this mismatch between *sắc* and the final glottal stop -ʔ has several manifestations and has led to modifications of Haudricourt's model that will be discussed below.

Haudricourt explicitly claimed that the f0 modifications of the glottal finals -h and -ʔ were automatic and redundant coarticulatory consequences of the production of final laryngeals. On the other hand, originally open syllables and syllables ending in sonorants were unmarked for f0. Therefore, the loss of the laryngeal opposition between sonorant finals, final -h and final -ʔ gave rise to a new distinction between a level (unmarked), a falling, and a rising tone, respectively. These three primordial tones derived from codas were then split into six tones divided into high and low series when the onset voicing contrast was neutralized. Therefore, tone formation from the loss of the laryngeal finals could be referred to as *tonogenesis proper* (i.e., the formation of tone in a previously atonal language), whereas the doubling of the tonal inventory, due to onset devoicing, is best characterized as a *tone split* (i.e., a change in the number of tones found in the language). Haudricourt's proposed diachrony for tonal development in Vietnamese is summarized in Table 2-2. In this table, *p* and *b* represent the two series of proto-voiceless and proto-voiced onsets (the voiceless onset *ƥ later became ɓ in the modern language).

Table 2-2. Development of tones in Vietnamese, according to Haudricourt (1954b).

Early Christian era (no tone)		*6th century CE (three tones)*	*12th century CE (six tones)*	*Now (six tones)*
Earlier	*Later*			
pa		pa	pa	ɓa
sla	l̥a	la	la	la
ba		ba	pà	ɓà
la		la	là	là
pas	pah	pà	pả	ɓả
slas	l̥ah	là	lả	lả
bas	bah	bà	pã	ɓã
las	lah	là	lã	lã
paX	paʔ	pá	pá	ɓá
slaX	laʔ	lá	lá	lá
baX	baʔ	bá	pạ	ɓạ
laX	laʔ	lá	lạ	lạ

It is worth considering a few minor points at this stage, which led to revisions to Haudricourt's schematization of Vietnamese tonogenesis in Table 2-2. First of all, he assumed an original voicing contrast in onset sonorants, perhaps derived from stop+sonorant clusters (represented by *l-* and *sl-* in Table 2-2), and postulated that the latter became voiced and conditioned high tones, patterning with the unchanged series of voiceless stops. He also assumed that the final fricative -h was not originally present in the proto-language, but derived from the final fricative -s. On the other hand, the origin of the final glottal stop -ʔ is not explicitly stated and its source is represented by the symbol X in the first column of Table 2-2. However, both -h and -ʔ were later reconstructed for Proto-Vietic (Nguyễn, 1995; Ferlus, 2014) and proto-Austroasiatic (Sidwell & Rau, 2014). In contrast with laryngeal codas, Haudricourt did not account for tones in checked syllables (i.e., syllables ending in

voiceless unreleased stops). Therefore, it is usually implicitly understood that these final stops had the same effect as that of the final glottal stop -ʔ on the preceding vowel and gave rise to *sắc nhập* and *nặng nhập* tones. Moreover, Haudricourt's model did not explain how the ʔ-derived rising tone gave rise to two tones, *sắc and nặng,* which have opposite contours in most modern Vietnamese dialects, nor why the h-derived falling tone evolved into falling-rising *hỏi* and *ngã*. Finally, the dating of tonogenetic events, like coda-derived tone formation (the 6th century CE) and tonal split (the 12th century CE), was not fully justified, even if brief mentions in the paper make it clear that they were based on the treatment of Chinese loanwords in Vietnamese. Careful efforts at dating proto-Việt-Mường tonogenesis were only attempted much later (Sagart, 1999; Phan, 2013; Alves, 2018).

Haudricourt's tonogenesis hypothesis has generally been accepted since 1954 and used, in part or in whole, to account for tonogenesis in other language families, not only in ESEA but in other regions of the world (Haudricourt, 1954a; Matisoff, 1973; Mazaudon, 1976; Gedney, 1986; Weidert, 1987; Sagart, 1989; Kingston, 2005; Guion et al., 2010; Kingston, 2011; Howe, 2017; Bang et al., 2018; Coetzee et al., 2018). Some revisions and modifications of the model will be discussed in the following sections. However, before we can do that, some notational conventions need to be introduced. In ESEA historical linguistics, tones are often represented with alphanumeric abbreviations referring to their diachronic sources: the letters A, B, C, and D indicate original final laryngeals (regardless of their modern reflexes) and the numbers 1, 2, and 3[9] refer to laryngeal properties of original initials (Li, 1977; Gedney, 1989; Michaud, 2004). The six-plus-two tones in Vietnamese can be marked

[9] For Vietnamese and other Vietic languages, only numbers 1 and 2 are used, representing the assumed voicelessness and voicing of onset obstruents that condition a two-way tonal split. In other language family, other series of onsets could also condition further tonal splits, such as aspirated and glottalized onsets.

with these alphanumeric labels, as shown in Table 2-3, to indicate their diachronic origin irrespective of later phonetic drift and dialectal variation between dialects. These abbreviations will be used throughout this dissertation.

Table 2-3. Alphanumeric assignment of Vietnamese tones with their native names (bracketed italic) and phonetic realization in Northern Vietnamese.

	Category A ***(<*-ɸ)***	***Category B*** ***(<*-ʔ)***	***Category C*** ***(<*-h/s)***	***Category D*** ***(<*-p/t/k)***
High series *(<*Voiceless onset)*	A1 (*ngang*) Level	B1 (*sắc*) Rising	C1 (*hỏi*) Middle broken	D1 (*sắc nhập*) Checked rising
Low series *(<*Voiced onset)*	A2 (*huyền*) Falling	B1 (*nặng*) Glottalized falling	C2 (*ngã*) Falling-rising	D2 (*nặng nhập*) Checked falling

b. Gregerson and Thomas (1976) *and radical modifications to the Haudricourtian model*

In their 1976 paper, Gregerson and Thomas not only provided more evidence from Austroasiatic languages in favour of Haudricourt (1954b)'s proposal on the -h/-s origin of Vietnamese C1-C2 (*hỏi-ngã*), but they also made significant modifications to the Haudricourtian model. This updated model is summarized in Table 2-4.

Table 2-4. Vietnamese tonogenesis as proposed by Gregerson and Thomas (1976).

Stage 1 *Two registers and subphonemic pitch height contour*	**Stage 2** *Six distinctive pitch contours with retained onset voicing*	**Stage 3** *Onset devoicing and phonemicization of six pitch profiles*	**Stage 4** *Implosivization of onset stops*	**Tone category**
pa	pa	pa	ɓa	A1
ba	bà	pà	ɓà	A2
paʔ	pá	pá	ɓá	B1
baʔ	bạ	pạ	ɓạ	B2
pah	pả	pả	ɓả	C1
bah	bã	pã	ɓã	C2

First, the authors proposed that at Stage 1 (beginning of the millennium), the proto-language already had a two-register contrast whose properties include contrastive high and low pitch. This pitch distinction was described as "subphonemic simultaneous features along with other consonantal [voicing] and vocalic factors" (1976, p. 82). This means that they considered the proto-language as having a voicing contrast, redundant with a typical Austroasiatic register contrast. At this stage, the final -h and -ʔ triggered a change in pitch on the preceding vowel, whose contours also slightly differed in the two registers.

At Stage 2, the loss of -h and -ʔ led to the emergence of contrastive pitch contours. At this stage, the proto-language would have had six surface tones, albeit voicing would have still been present, making the split between High and Low register tones subphonemic. These six tones were then phonemicized in Stage 3 when onset devoicing took place.

c. Gage (1985) *and the remaining unsolved problem of final glottalization*

Gage (1985) is largely devoted to the issue of (mis)matches between B1/B2 (*sắc/nặng*) tones in Vietnamese and Austroasiatic final glottal stops from which the former was predicted to be derivable as suggested in Haudricourt (1954b). Gage pointed out a bi-directional mismatch between Vietnamese tones B1/B2 and the final glottal stop -ʔ that had been overlooked by Haudricourt:

(i) Some Vietnamese words with B1/B2 tones correspond to words ending in a vowel (open syllables) in other Austroasiatic languages and should therefore bear tones A1/A2.

(ii) Some words ending in a glottal stop -ʔ in other Austroasiatic languages do not bear Vietnamese B1/B2 tones but instead have A1/A2 tones.

Some representative examples from Gage (1985) are given in Table 2-5 and Table 2-6.

Table 2-5. Vietnamese B1 tone corresponds to open syllables in other Austroasiatic languages.

Gloss	*Vietnamese*	*Proto-Mnong*	*Proto-North Bahnaric*	*Bru*	*Katu*
fish	ka ^{B1}	ka	ka	-	-
dog	cɔ ^{B1}	sɔ	cɔ	acɔ	acɔ
gape	ha ^{B1}	ha	ha	-	-
grandchild	caw ^{B1}	săw	căw	câu	sasaau
louse	ci ^{B1}	si	cì	ncêi	ncai

Table 2-6. Vietnamese A1 tone corresponds to -ʔ in Ryang (Palaungic, Austroasiatic).

Gloss	*Vietnamese*	*Ryang*
you	mi ^{A1}	miʔ
calf	be ^{A1}	pɛʔ
fig tree	si ^{A1}	səriʔ
deep	sɤ̆w ^{A1}	tsəruʔ

If one trusts Shorto (1976)'s reconstruction of proto-Austroasiatic vocalism and Diffloth (1980)'s reconstruction of proto-Waic, proto-Austroasiatic had no open syllables. However, according to Gage, all Khmer cognates of Mon words with a final -ʔ end in a vowel (1985, p. 26). This seems to suggest that the proto-Austroasiatic -ʔ was entirely preserved in some languages like Mon but dropped in some syllables in other languages like Khmer. According to Diffloth (1989a), as proto-Austroasiatic had no open syllables, its daughters could have dropped the final glottal stop -ʔ unconditionally without risking lexical confusion. Proto-Vietic could have turned proto-Austroasiatic -ʔ into a rising tone in words in which other languages lost the coda -ʔ, explaining cases like those in Table 2-5. The change would have gone in the opposite direction in other words, as in Table 2-6, where the proto-Austroasiatic -ʔ was lost in proto-Việt-Mường but not in Ryang. The

problem with this explanation, of course, is that it does not provide a systematic account of the factors that would have conditioned the loss of -ʔ in some words and languages, but not in others.

Gage (1985) did not come up with an explanation for the development of Vietnamese B1/B2 tones in sonorant-ending syllables. However, he found promising correspondences between Chong (Pearic, Austroasiatic) non-glottalized and glottalized final sonorants and Vietnamese A1 and B1 tones (examples are reproduced in Table 2-7). This update was later explicitly integrated into Haudricourt's model by other researchers (Diffloth, 1989a; Ferlus, 2004). Gage presented all these examples as "the most encouraging indications yet found in support of Haudricourt's hypothesis, allowing us to extend it beyond open syllables." (1985, p. 33).

Table 2-7. Chong non-glottalized and glottalized final sonorants vs. Vietnamese A1 and B1 tones.

Gloss	*Vietnamese*	*Chong*
cooked	cin ^{B1}	chiiʔn
four	ɓon ^{B1}	phooʔn
wind	zɔ ^{B1}	kyaʔl
far	ŋaj ^{B1}	cŋɔʔy
child	kɔn ^{A1}	kheen
stick	kx̌j ^{A1}	tkool

d. Diffloth (1989a) *and proto-Austroasiatic creaky voice*

Diffloth (1989a) argued that there existed a register distinction between creaky and clear vowels at the proto-Austroasiatic level, based on his reconstruction of this distinction in proto-Katuic, proto-Pearic, and Proto-Vietic. He argued that this proto-register contrast gave rise to glottalized codas in Ong (Katuic), the creaky component in the Chong four-

way register contrast, and, most relevant here, reflexes of B1/B2 tones in sonorant-ending syllables in Vietnamese. The distribution of clear and creaky series of Proto-Vietic vowels with different coda types according to Diffloth is in Table 2-8. Creaky vowels have a more restricted distribution than clear vowels, as the former only occur in unchecked syllables (unshaded cells in Table 2-8). Note that diachronically, V̰ does not differ from Vʔ and should give rise to the same tone categories. Marked in green is the unconditional loss of the final glottal stop -ʔ in a subset of glottal stop ending syllables in Proto-Vietic. According to Diffloth, this segmental loss was random and not compensated for (Diffloth, 1989a, p. 152, endnote 15) because it happened when the language had no open syllables, and therefore there was no risk of lexical confusion.

Table 2-8. Distribution of clear and creaky vowels with codas in Proto-Vietic. Shaded cells represent illegitimate combinations.

	Open *-ɸ*	*Sonorants* *-m n ɲ ŋ r l j w*	*Glottal stop* *-ʔ*		*Glottal fricatives* *-h s*	*Stops* *-p t c k*
Clear	**V**	**VN**	**Vʔ**	**Vʔ > V**	**VH**	**VC**
Creaky	**V̰**	**V̰N > VNʔ**				

Diffloth then proposed an updated version of Haudricourt's tonogenesis hypothesis for Vietnamese (1989a, p. 148). It is summarized in Table 2-9.

Table 2-9. Creaky vs. clear vowels and tonogenesis in Vietnamese.

	Open *-ɸ*		*Sonorants* *-m n ɲ ŋ r l j w*		*Glottal stop* *-ʔ*		*Glottal fricatives* *-h s*	*Stops* *-p t c k*
	V	V̰	VN	V̰N > VNʔ	Vʔ	Vʔ > V (unconditioned loss of -ʔ)	VH	VC
**voiceless*	**A1**	**B1**	**A1**	**B1**	**B1**	**A1**	**C1**	**D1**
**voiced*	**A2**	**B2**	**A2**	**B2**	**B2**	**A2**	**C2**	**D2**

Diffloth's updates to the Haudricourtian hypothesis help to explain three patterns in Vietnamese tone development. First, if the proposed proto-Austroasiatic creaky phonation was lost in Austroasiatic families other than proto-Katuic, proto-Pearic, and Proto-Vietic, the second column in Table 2-9 illustrates the correspondence between Vietnamese B1/B2 tones and open syllables in other languages. Secondly, Diffloth's model explains the existence of glottalized rhymes in sonorant-ending syllables, which could later develop into some kind of pre- or post-glottalization on final sonorants or even into sonorants + glottal stop clusters (the fourth column in Table 2-9). This type of rhyme gave rise to B1/B2 tones by the same mechanism applied to ʔ-ending syllables (Haudricourt, 1954b). Lastly, the unconditioned loss of Proto-Vietic -ʔ in -Vʔ rhyme (column 6 in Table 2-9) explain the correspondence between Vietnamese B1/B2 tones and cognates with -ʔ in other Austroasiatic languages that preserve this segment. However, it is hard to explain this unconditioned sound change, particularly how it developed differently in various Austroasiatic languages.

Glottalized final sonorants are indeed attested in Vietic languages like Arem (Nguyễn, 1988; Ferlus, 2013), Rục (Nguyễn, 1993; Solntsev et al., 2001a), Kri (Enfield & Diffloth, 2009), but their historical source (if any) is not clear. Moreover, the glottalized (creaky) component in Pearic and Katuic languages was proposed to derive from the vowel-height-conditioned phonation types that arose in these two branches independently (Gehrmann, 2015; Gehrmann & Conver, 2015; Gehrmann, 2017; 2022, more later in this section). These sheds doubt on Diffloth's reconstruction of a creaky voice in proto-Austroasiatic. In response to Diffloth's hypothesis, Ferlus (2004) proposed that the glottalized sonorants and creaky vowels are a shared innovation in the three Austroasiatic families that have creaky rhymes.

e. Ferlus (2004) *and sesquisyllabic tenseness*

Ferlus (2004) questioned the validity of Diffloth's proposal on proto-Austroasiatic creaky voice and instead put forth an alternative scenario. He argued that the final syllable of sesquisyllabic words—words in which a main stressed syllable is preceded by an unstressed and more phonologically restricted presyllable, cf. Chapter 3—developed a tenser voice quality than monosyllables when they underwent monosyllabicization, a process widespread in ESEA languages (Ferlus, 1998a; Brunelle & Pittayaporn, 2012; Michaud, 2012): *CVCV(C)> CV(C)^{TENSE} and *CV(C) > CV(C)^{LAX}. He hypothesizes that this tense/lax distinction first occurred in Old Chinese (Ferlus, 1998a)[10] and then spread to the ancestors of Katuic, Pearic, and Vietic via contact (Ferlus, 2011). According to the author, this tenseness is due to "the coalescence of the double onset tenseness of the initial cluster C-C-" (2011, p. 306).

This tenseness would have created new syllable structures after the completion of monosyllabification:

- Glottalization of the vowel of the open syllable, therefore V^{ʔ}, which would have been phonologically similar to originally Vʔ;
- Dropping of the glottal stop -ʔ in the previous rhyme of Vʔ, resulting in open syllables;
- Glottalization of final sonorants, leading to N^{ʔ};
- No effect on final stops and final fricative -h/s.

The behaviour of these new syllable structures during tonogenesis is schematized in Table 2-10, a modification from Ferlus (2004, p. 310).

[10] From Old Chinese to Midle Chinese this tense/lax distintion was transphonologized into vowel quality distinctions, which Ferlus claimed to be the origin of Chinese "four divisions (of vowel openess)" (Ferlus, 1998a, 2009).

Table 2-10. Sesquisyllabism Tense/Lax distinction and tonogenesis in Vietnamese.

	Open *-ɸ*		*Sonorants* *-m n ɲ ŋ r l j w*		*Glottal stop* *-ʔ*		*Glottal fricatives* *-h s*	*Stops* *-p t c k*
	Lax *CV > CV	Tense *C-CV > CVʔ	Lax *CVN > CVN	Tense *C-CVN > CVNʔ	Lax *CVʔ > CVʔ	Tense *C-CVʔ > CV	-VH	-VC
******voiceless*	**A1**	**B1**	**A1**	**B1**	**B1**	**A1**	**C1**	**D1**
******voiced*	**A2**	**B2**	**A2**	**B2**	**B2**	**A2**	**C2**	**D2**

Ferlus' sesquisyllabic tenseness model seems to nicely handle the existence of glottalized final sonorants in Vietic and explains why B1/B2 tones often developed on sonorant final-syllables, just like syllables ending in a final glottal stop -ʔ, in Proto-Vietic. This model also provides a possible explanation for the loss of the final glottal stop -ʔ that led to the formation of A1/A2 tones instead of B1/B2 (column 6 in Table 2-10). This latter solution is an alternative to Diffloth's (1989a) suggestion of an unconditioned loss of the segment in part of the Proto-Vietic vocabulary and seems to be phonologically better as the conditioning context is well-defined. However, to my knowledge, the introduction of tenseness caused by the coalescence of consonants in sesquisyllabic words is rare in the world's languages. A possible case is the tension of geminated consonants derived from reduced reduplicative words that conditioned a high tone in some New Caledonian languages (Austronesian) (Rivierre, 1993, 2001). Moreover, in other Vietic languages that preserve a large proportion of sesquisyllabic words in their lexicon, there has been no establishment of any kind of tenseness in sesquisyllables that is not also found in monosyllables (Suwilai, 1996; Solntsev et al., 2001a; Enfield & Diffloth, 2009; Gehrmann, 2015). Moreover, the proposed mechanism does not account for words that preserve the presyllable yet either have a glottalized rhyme or developed B tones, like 'thunder' Proto-Vietic *k-rəmʔ, Vietnamese *sɤm* ^{B1}, Arem kərɨ̀mʔ, Ruc kʰlɨm^{B2}, Maleng kɨrɨ̀mʔ; and 'wind' Proto-Vietic *k-jɔːʔ, Vietnamese zɔː ^{B1}, Arem, Maleng kajɑːʔ, Ruc kajɰ́ː, Thavung kajɰ̂ː.

It is also hard to imagine how a phonological process could be easily and uniformly transferred from one language (Old Chinese) to other languages (Late Proto-Vietic, Late Proto-Pearic, and Late Proto-Katuic) via contact. Even if this happened, one should expect it had a greater effect on Late Proto-Vietic than on the other proto-languages because of

the more extensive contact between Chinese and the former starting from the beginning of the first millennium. The "trade route" or "Han trail" connecting the Han empire to Katuic- and Pearic-speaking areas through ancient Vietnam territory proposed by Ferlus is not well-attested historically and would not have resulted in enough direct contact to induce phonological borrowing from Old Chinese to these languages. As Ferlus himself admits, his hypothesis on sesquisyllabic tenseness has not been widely accepted (Ferlus, 2009) and still calls for a more systematic investigation of the relevant languages.

According to Ferlus (1999), tenseness was not the only sesquisyllabicity-induced factor that affected tone correspondence. Sesquisyllabicity also caused two types of tonal disharmonies between innovative northern languages Vietnamese, Mường, and Nguồn on the one hand, and more conservative south languages such as Chứt, Arem, and Thavung on the other hand.

In the first type of tonal disharmony, the northern group has a high tone, while the southern group has a low tone. Ferlus only provides two examples of this, which I reproduce here (1999, pp. 86-87).

'rain'. North languages: Vietnamese *miə*^{A1}; Mường, Nguồn *miə*^{A1}.
South languages: Cuối *mɐ*^{A2}; Pong *kᵊma*^{A2}; Toum, Liha *ma*^{A2}; Sách/Rục *kŭməà*^{A2}; Arem *mìə*^{A2}.

'thunder'. North languages: Vietnamese sɤm^{B1}; Mường *ʃʌm*^{B1} | *kʰʌm*^{B1};
Nguồn *kʰʌm*^{B1}.
South languages: Cuối *kʰrʌm*^{B2}; Sách/Rục *kʰrɨ̀m*^{B2}; Arem *kʰrɨ̀mˀ*^{B2};
Malengbrô *kᵊrɨ̀mˀ*^{B2}; Mãliềng *kᵊɣɨ̀m*^{B2}.

Ferlus' explanation for this tonal disharmony is that the vowel (V) of the presyllable in Proto-Vietic 'rain' ***kV-ma** and 'thunder' ***kV-rəmʔ** was preserved or changed into a

schwa in southern languages, separating the onsets of presyllable from the main syllable. The tone on the main syllable was determined by its voiced sonorant onset, which led to the development of a regular low tone. In contrast, northern languages underwent monosyllabicization (under Chinese influence, according to Ferlus), which caused sesquisyllabic words to develop an initial cluster. The voiceless initial of the cluster devoiced the following sonorant (through an aspiration stage according to Ferlus), as in *kV-ma > *k^{h}ma and *kV-rəm^{ʔ} > k^{h}ram^{ʔ}, leading to the development of a high tone.

In the second type of disharmony, cognates have low tones in Vietnamese and high-tone counterparts in other Vietic languages. Ferlus provided seven examples of this, three of which are reproduced here.

'chicken'. Vietnamese *ɣa:^{A2}*;
Mường, Cuối, Pong, Thavung *ka:^{A1}*; Sách/Rục *r^{ə}ka:^{A1}*;
Arem *l^{ə}kæ^{A1}*; Mãliềng *ŭka:^{A1}*.

'husked rice'. Vietnamese *ɣa:w^{B2}*;
Mường *ka:w^{B1}*; Cuối *kɔ:^{B1}*; Pong *kɔ:^{B1}*; Thavung *akɔ:^{B1} | ŋkɔ:^{B}*;
Sách/Rục *r^{ə}ko:^{B1} | tko:^{B1}*; Arem *ŋkɔ^{ʔB1}*.

'bed bug'. Vietnamese *ze:p^{D2}*
Pong *si:p^{D1}*; Thavung, Sách/Rục *k^{ə}si:p^{D1}*; Arem *k^{ə}t^{h}ɪ:p^{D1}*;
Maleng brô *krsɪ:p^{D1}*.

Only Vietnamese has low tones on the cognates because of a "spirantization" of medial stops that happened in this language alone (Ferlus, 1982): the onsets of the main syllables in the three above cognates **r-ka:, *r-ko:^{ʔ},* and **kr-si:p* were spirantized to become voiced fricative *ɣ* and *z* in Vietnamese, and these voiced onsets in turn designated the low tones.

Even if the two sesquisyllabicity-conditioned tonogenetic mechanisms above are generally accurate, the small number of examples given by Ferlus suggests that they are not easy to fully reconstruct. This is because monosyllabicization occurs differently from language to language, not to mention in the context of the same language over time, and that it does not happen uniformly across the entire lexicon of a language (Thomas, 1992; Nguyễn, 1993; Michaud, 2012; Pittayaporn, Enfield, & Comrie, 2015).

f. Gehrmann (2022) *and vowel-height-conditioned creakiness*

Gehrman (2022) proposes another alternative historical source for the glottalized rhymes shared by proto-Pearic, proto-Katuic, and Proto-Vietic. His specific proposal for Proto-Vietic tonation formation includes two steps and can be summarized as follows.

In early Proto-Vietic, vowel height conditioned a phonation distinction: closed vowels developed a breathy voice quality while open vowels retained a relatively modal voice quality. He does not mention whether this registrogenesis caused any vowel merger in Proto-Vietic following what happened with mid vowels in proto-Katuic (Diffloth, 2009; Gehrmann, 2015). Then, onset voicing was neutralized, and a creaky (tense) voice quality developed on rhymes following original voiceless onsets. The combination of the earlier breathiness contrast with this new creakiness led to the development of four distinctive phonation types: modal vs. creaky vs. breathy vs. breathy-creaky, in a manner similar to what is found in Chong (Huffman, 1985a; Thongkum, 1986; DiCanio, 2009). In later Proto-Vietic, the two phonation types with a creaky component, creaky and breathy-creaky, mutated differently depending on their codas:

- [-VH] and [-VC]: the creaky and breathy-creaky phonations were neutralized to modal and breathy phonation, respectively, i.e., V'H, V'C > VH, VC, and V̰'H, V̰'C > V̰H

and V̤C. Here, the author implicitly assumes that the creakiness from vowel phonation and from the glottal feature of finals -H and -C cancel out each other, leaving no other change in the segmental or suprasegmental structure of the syllables. To the best of my knowledge, such a pattern has never been attested, diachronically or synchronically.

- [-Vʔ]: the final glottal stop -ʔ was dropped, being cancelled out by the creaky component of vowel phonation, i.e., V'ʔ > V. Again, such a scenario, which is similar to that proposed in Ferlus (2004), is not attested in any known language. A dissimilation of "glottal incidents" that both start and end pre-syllable is reconstructed in Lahu (Tibeto-Burman), but it gave rise to a high-rising tone (Matisoff, 1970).

- [-VN]: final sonorants were glottalized as the creaky phonation of the vowel was delayed and extended to these finals, i.e., V'N > VNˀ. The breathy phonation in V̤N was preserved, predicting that Proto-Vietic VN with open vowels should have tones B2 in Vietnamese.

Gehrmann's model is schematized in Table 2-11.

Table 2-11. Registrogenesis and tonogenesis in Vietnamese, by Gehrmann (2022). More in the text.

	Stage 1: Vowel-height-conditioned register		Stage 2: Onset-conditioned register		Stage 3 & 4: Rhyme mutation and tonogenesis			
	**open vowels*	**closer vowels*	**open vowels*	**closer vowels*	**open vowels*		**closer vowels*	
Open *-ϕ*	V	V̤	V’	V	V	**A1**	V	**A1**
			V̤’	V̤	V̤	**A2**	V̤	**A2**
Sonorants *-m n ɲ ŋ r l j w*	VN	V̤N	V’N	VN	VN[ʔ]	**B1**	VN	**A1**
			V̤’N	V̤N	V̤N[ʔ]	**B2**	V̤N	**A2**
Glottal stop *-ʔ*	Vʔ	V̤ʔ	V’ʔ	Vʔ	V	**A1**	Vʔ	**B1**
			V̤’ʔ	V̤ʔ	V̤	**A2**	V̤ʔ	**B2**
Glottal fricatives *-h s*	VH	V̤H	V’H	VH	VH	**C1**	VH	**C1**
			V̤’H	V̤H	V̤H	**C2**	V̤H	**C2**
Stops *-p t c k*	VC	V̤C	V’C	VC	VC	**D1**	VC	**D1**
			V̤’C	V̤C	V̤C	**D2**	V̤C	**D2**

*voiceless *voiced ’ Creaky voice ̤ Breathy voice

The first problem with Gehrman’s model is that it resorts to a very complex sequence of changes that would have left no traces in open syllables and in syllables closed by glottal fricatives and stops. Another problem is that it postulates complex combinations of breathy-creaky phonation (V̤’) and of glottal codas (-ʔ, -h/s) and final stops at stage 2 (orange cells in Table 2-11) whose existence is questionable from a phonetic point of view

as the combination of three different glottal events in the same syllable has not been attested anywhere in the world's languages. Another problem is that the change from V̰ (< *close vowels) to V in the context of proto-voiceless onsets (blue cells in Table 2-11) is not attested in any other language[11]. The author does not elaborate on how breathiness (on the vowel) and tense phonation (from voiceless onset) would cancel each other out, but simply claims that there was a general tensing of all vowel phonation.

More importantly, Gehrmann's proposal on vowel height-induced phonation developments in Proto-Vietic is not supported by evidence from known reconstructions of the proto-language (Nguyễn, 1995; Ferlus, 2014). The author provides neither specific lexical evidence nor concrete reconstructions to illustrate the hypothesis. More systemic lexical comparisons are needed, but I provide preliminary counterevidence. Note that the proposal predicts that Proto-Vietic VN gave rise to B and only B tones if V was an open vowel, and A and only A tones if V was a closed vowel (lines for sonorants codas in Table 2-11). However, one can still find A tones for the former and B tones for the latter. Some examples are given below in Table 2-12. Given the lack of phonetic motivation for the proposed historical changes of phonation types in the theory, I will not investigate tonation systems in Vietic languages in this vein.

[11] In Todrah (Gregerson & Smith, 1973) (North Bahnaric), the tense register caused a drop of -h and a debuccalization of final stops, but this is a different story from the proposal on the high (tense) register cancelling the breathiness of vowels in proto-Vietic, as the former involved a single sound change and it affected finals instead of vowels.

Table 2-12. Cognates of Proto-Vietic VN rhyme in Vietnamese, as predicted by Gehrman (2022) and their attested forms. *p* stands for proto voiceless onsets, *b* voiced onsets, *i* close vowels, and *a* open vowels.

Proto form	*Proposal prediction*	*Attested cognates*	*Examples*	*Gloss*
*paN	-aN^{B1}	-aN^{A1}	*ta:ɲ > ɗa:n^{A1}	*weaving*
			*t-ɓa:ŋ > ma:ŋ^{A1}	*deer*
			*t-ka:n > ɣa:n^{A1}	*liver*
			*kɔ:n > kɔ:n^{A1}	*child*
			*ʔɛ:m > ɛ:m^{A1}	*younger sibling*
*baN	-aN^{B2}	-aN^{A2}	*da:n > ɗa:n^{A2}	*herd, swam*
			*da:ŋ > ɗɨəŋ^{A2}	*sugarcane*
			*ɟa:m > ca:m^{A2}	*indigo*
			*m-rɔ:j > zuəj^{A2}	*flies*
			*vɔ:j > vɔ:j ^{A2}	*elephant trunk*
*piN	-iN^{A1}	-iN^{B1}	*ci:nʔ > *ci:n^{B1}	*cooked*
			*ci:nʔ > *ci:n^{B1}	*nine*
			*k-ɲi:mʔ > ɲi:m^{B1}	*porcupine*
			*p-su:ɲʔ > zo:n^{B1}	*navel*
			*su:lʔ > to:j^{B1}	*evening*
*biN	-iN^{A2}	-iN^{B2}	*bu:lʔ > ɓu:j^{B2}	*dust*
			*bu:lʔ > ɓu:j^{B2}	*clump*

Overall, this section shows that Haudricourt (1954b)'s hypothesis on tone development in Vietnamese is generally accepted. Subsequent studies by other researchers either provide more lexical correspondences from Austroasiatic languages that were not available at the time or fine-tune the tonogenetic mechanisms, focusing on the relation between the final glottal stop -ʔ, glottalized/laryngealized sonorants, and tone categories A and B. There is, on the other hand, a general consensus regarding the mapping between final fricatives -h/s and tones C1/C2. Researchers also seem to agree that tonogenesis from

the loss of laryngeal codas happened prior to the loss of onset voicing, therefore, tonogenesis > tone split, but the opposite order has also been proposed (Gregerson & Thomas, 1976; Gehrmann, 2022). The periodization of tonogenesis and tonal split will be discussed in detail in §2.4.

2.3 Register and registrogenesis

2.3.1 Definitions of register

The term *register* is used and understood in many ways, depending on areas and sub-fields of linguistics. In its most common usage, *register* is "a cover term for any language variety defined by its situational characteristics, including the speaker's purpose, the relationship between speaker and hearer, and the production circumstances" (Brown, 2006, p. 476). These social components then regulate how specific types of vocabulary, sentence structures, and punctuation are used in discourse. Lexicographers use labels in dictionaries to guide learners on using lexical entries appropriately in different registers such as *fml.* (formal), *infml.* (informal), *sl.* (slang).

In phonetics, *register* refers to the "voice quality produced by a specific physiological constitution of the larynx" (Crystal, 2008, p. 409), such as the idiosyncratic length, thickness, tension of vocal folds, and the size of the pharynx of individuals. This meaning of the term is very similar to the way in which it is used by voice and music experts when they divide a singer's pitch range into different levels, such as "chest" (modal, normal) voice, middle voice, and "head" (falsetto) voice.

Pike (1948) used the term *register* for "register tone languages," a type of language

whose tonal units (tonemes) are identified by their relative pitch height but not their contour. Register tones contrast with contour tones, whose characteristic is pitch change over time.

The term *register* was first defined and used in the ESEA linguistic literature by Henderson (1952) in her study on the pronunciation of Cambodian Khmer, although Shorto was the first to use it in his description of the vowel system of modern Mon (according to Jenner, 1974). Register was used to categorize the differences between the two types of rhymes in the language. What conditions these two rhymes is usually assumed to be the devoicing and the subsequent merger of the voiced onsets series with the voiceless series. This earlier voicing contrast in onsets is replaced by a bundle of new phonetic distinctions on the following vowel, including phonation type, pitch (f0), vowel quality (vowel change), and vowel duration. In this sense, register is phonologically and functionally equivalent to tone in a two-tone language. However, as Henderson emphasizes, register differs from tone in that "pitch is not the primary relevant feature. The pitch ranges of the two registers may sometimes overlap" (1952, p. 151). Here are some (nearly) minimal pairs exemplifying the register distinction (notice the change in phonetic realization of vowels in the two registers):

Table 2-13. Minimal pairs of register distinction in Cambodian Khmer.

First register	*Second register*
តា *taa > [taa] (*grandfather*)	ទា *daa > [tiə] (*duck*)
តោ *tɔɔ > [tɑɑ] (*to continue*)	ទោ *dɔɔ > [tɔɔ] (*to blame*)
កី *kii > [kəy] (*loom*)	គី *gii > [kii] (*pickled shrimp)*

It took some time for the concept of register to be widely recognized, but from the late 1960s, studies on an expanding number of languages gradually established its pervasiveness in the area, and more detailed and accurate phonetic correlates of the distinction became available (Gregerson, 1976; Huffman, 1976; Ferlus, 1979a; Huffman, 1985b; Thongkum, 1988; Diffloth, 1989b; Ferlus, 1998b; Brunelle, 2005; Enfield & Diffloth, 2009). These studies show that the phonetic implementation of register differs from language to language (and even from dialect to dialect), both in their nature and the extent to which the acoustic features are involved. Table 2-14 summarizes the possible correlates of the two registers in ESEA languages.

Table 2-14. Possible phonetic correlates of registers (Brunelle & Kirby, 2016: 193).

High register (< voiceless stops, [*pa])	*Low register* (< voiced stops, [*ba])
Higher pitch	Lower pitch
Tense/modal voice	Lax/breathy voice
Monophthongs/shorter vowels	Diphthongs/longer vowels
Raised F1/lower vowels/[+ATR]	Lowered F1/higher vowels/[-ATR]
Plain stops/shorter VOT	Aspirated stops/longer VOT

Although this will not be relevant for Vietic, an additional point that needs to be noted is that although the register distinction is usually binary, there are languages in which three or even four different types of register are reported. For example, Luang-Thongkum (1987) claims that in Mon, the voiceless sonorants raise the f0 of the following vowel higher than the regular High register; therefore, the language could be considered as having three registers. More noticeable is the Pearic language Chong of Thailand, which has four registers mainly characterized by phonation types: clear, breathy, creaky, and breathy-creaky (Huffman, 1985a; Thongkum, 1986; Edmondson, 1996; DiCanio, 2009).

2.3.2 Registrogenesis and registrogenetic models

2.3.2.1 Registrogenesis

The register phenomenon in Mon and Khmer was first noticed and described in the literature at the very beginning of the 20th century (Haswell, 1901; Blagden, 1910) when scholars noted that Indic graphemes used to represent voiced and voiceless stops actually signal a distinction between two series of vowels and, to some extent, the voice qualities of these series. The voicing contrast was then presumed to be lost in these languages and to have given rise to the differences on adjacent rhymes, which constituted the first (implicit) hypothesis on the formation of register. This neutralization of voicing, which was later shown to be the most frequent source of register formation in ESEA languages (Huffman, 1976; Ferlus, 1979a; Brunelle & Tạ, 2021), is usually called the "Khmer Model" or "Onset Phonation" (Wayland & Jongman, 2002; Gehrmann, 2022). However, the first use of the term *registrogenesis* in a publication is paradoxically found in Diffloth (1982), a study on a rare form of register development in Katuic languages. In these languages, register develops out of vowel quality, a process that Diffloth labelled "heretical registrogenesis."

For the moment, I will use *registrogenesis* to refer *to a phonological change in which a language gains a register distinction* (as defined in Section 2.3.1), whose most common source is onset voicing. In the next section, I mainly look at models of registrogenesis triggered by the loss of onset voicing, as it is the most common type and the only relevant one in Vietic languages (Haudricourt, 1954b; Ferlus, 1990, 1996; Enfield & Diffloth, 2009). In this dissertation, I am not concerned with the "heretic" vowel height-derived register contrast (Diffloth, 1982; Svantesson, 1989; Svantesson, 2001; Sidwell, 2005; Gehrmann, 2022). The models discussed in this section include the mechanism put forward

by Haudricourt (1965) in his study on consonant shifts in Austroasiatic languages, the first explicit and detailed diachronic treatment of registrogenesis by Huffman (1976), a phonetic explanation of registrogenesis by Gregerson (1976), and Ferlus (1979a)'s typology of registrogenesis. Complex registrogenesis, described in a recent attempt to unify tonogenesis and registrogenesis (Thurgood, 2002; Gehrmann, 2022), will be discussed in a separate section (§2.4.4).

2.3.2.2 Models of registrogenesis

a. Haudricourt (1954) – Consonantal mutations

Haudricourt (1954b) agreed with Maspero (1912) that the loss of the onset voicing contrast had conditioned a split into high and low tones in Vietnamese, Middle Chinese, and Tai languages. But onset devoicing does not only result in tonal splits. In his 1965 paper, Haudricourt explicitly describes three types of consonant shifts involving voiced and voiceless stops in onsets in Austroasiatic languages. In the first consonantal mutation, called the "Germanic" type, voiced onset stops devoice, and unaspirated voiceless ones become aspirated to preserve phonological distinctiveness. In the second mutation, which Haudricourt called the "Mon-Khmer" type and that corresponds to the Austroasiatic register, voiced onsets devoice and merge with the unchanged voiceless onsets. The former conditions a breathier voice quality, a lower pitch, and a "laxer" vowel quality on the following vowel compared to syllables with historical voiceless onsets. Haudricourt named the last type the "Far Eastern" mutation. It involves the same consonantal mutation as in the "Mon-Khmer" type, except that it occurs in languages with a pre-existing tone system like Vietnamese, Chinese, or Thai. This results in a two-way tonal split, assumed by Haudricourt to be primarily pitch-based.

b. Huffman (1976) – Phonological changes and classification

Huffman (1976) described the onset voicing and register contrasts of fifteen Mon-Khmer languages. He classified them into four groups, from the most conservative to the most innovative, based on the preservation/absence of voicing and register correlates. According to this classification, *conservative* languages include Loven, Lava, Stieng, and Brao (retention of voicing); *transitional* languages include Alak, Souei, Nghe?, Mal, and Tampoun (decaying voicing, sub-phonemic registers); *register* languages include Kuy, Chaobon, Chong, Bru, Mon (distinctive phonation and vowel quality); and the sample comprises one *restructured* language Cambodian Khmer (register replaced by a vowel split). In a later paper, *Vowel permutations in Austroasiatic languages,* Huffman (1985b) provides more details on register-conditioned vowel changes.

Based on these data, Huffman proposes a five-stage scenario for registrogenesis, assuming an onset voicing contrast in the proto-language. The descriptions of these stages are reproduced in Table 2-15. To my knowledge, this is the first explicit model of registrogenesis.

Table 2-15. Five-stage development of register in Mon-Khmer languages (Huffman, 1976: 578). "Continuants" here means "sonorants".

Stage 1	Voiceless:voiced distinction in initial stops; two-way distinction in initial continuants; as yet little or no vowel differentiation.
Stage 2	Simultaneous change in the articulation of one set of initial consonants and development of allophonic variation in following vowels, still in complementary distribution *vis-à-vis* two distinctive sets of initials.
Stage 3	Register becomes phonemic due to a complete merger at some point in the system, probably in the continuants, with retention of allophonic distinction in initials in complementary distribution *vis-à-vis* first and second register vowel.

Stage 4	Complete merger of initial stops, with complete register dichotomy in the vowels.
Stage 5	Loss of register contrast due to change in vowel position and diphthongization.

The shift from Stage 1 to Stage 3 in this scenario is equivalent to what is called "transphonologization" by Ferlus (1979a) or "phonologization" by Hyman (1976), where intrinsic-phonetic features of the vowels induced by properties of the initial consonants become extrinsic-phonological. The shift from Stage 3 to Stage 4 parallels Hyman's "phonemicization" process in that register becomes distinctive-phonemic. The "registrogenesis" process proposed by Huffman could be summarised in Table 2-16, adapted from Brunelle & Kirby (2016, p. 194).

Table 2-16. Diachronic development of register in Mon-Khmer languages.

Register	**Stage 1: voicing**	**Stage 2: transitional** *(Huffman's Stages 2 and 3)*	**Stage 3: register** *(Huffman's Stage 4)*	**Stage 4: vowel change** *(Huffman's Stage 5)*
1	kaa	kaa	káa	kaa
2	gaa	k´aa	kạ̀a	kiə

The reason for the presence of Stage 3 in Huffman's scenario is that some languages first developed a register distinction in syllables with sonorant initials, caused by the loss of contrast between voiceless and voiced sonorants (Mon, Loven, Lawa). Only after this did the register contrast develop on syllables with stop initials from the neutralization of the onset voicing contrast.

Another element of Huffman's scenario that needs further articulation is the restructuring of register (Stage 5). A typical register distinction involves multiple phonetic cues, like phonation type, vowel quality, and f0 height. However, different languages may

drop all but a single cue. Therefore, besides a restructured vowel system (Cambodian Khmer, Brou…), a register dichotomy could yield a tonal contrast (Northern and Western Khmu) or a constrictive-register (Sedang) – a set of possibilities that were unknown to Huffman when he wrote his paper (Ferlus, 1979a).

Huffman seems to assume that, although languages do not need to go through all stages and could be at a specific stage for a very long time, the sequence of stages is fixed and uniform across languages. However, experimental data obtained from other languages in recent years show that a language could go directly from an onset voicing to a register contrast, even if onset voicing is still present as an optional and sub-phonemic phenomenon. For example, although onset voicing is still optionally present in Southern Raglai and Chru (Chamic, Austronesian) (Brunelle et al., 2020; Brunelle et al., 2022a) and Chrau (Bahnaric, Austroasiatic) (Tạ et al., 2022), these three languages have developed full-fledged register systems based primarily on vowel quality and phonation type.

c. Gregerson (1976) – An articulatory explanation of register

Inspired by a study on the role of the tongue root in vowel harmony in the West African language Akan (Stewart, 1967), Gregerson (1976) attempted to account for all phonetic correlates of the register contrast in Mon-Khmer languages with a single articulatory mechanism: tongue root position. He argued that all the features related to register, such as phonation type, vowel quality, f0, and even voicing of initial consonants, are direct consequences of advancing or retracting the tongue root (see Table 2-17). In his words, all these features "coexist[ed]…, constituting a multi-feature prosodic opposition dichotomizing all syllables (or phonological words)" (1976, p. 343).

Table 2-17. Tongue-root position and its consequences (Gregerson, 1976).

	Tongue root advanced	*Tongue root retracted*
Voicing of initials	Enlarges the pharynx which consequently reduces intraoral pressure to allow airflow through the glottis and sustain the vibration of vocal folds.	Reduces the size of the pharynx, which reduces supraglottal pressure and thus hinders vocal fold vibrations.
Pitch	Produces more glottal tension which in turn increases the rate of vocal fold vibration (f0 increasing).	Loosens the vocal folds, making them vibrate slower (f0 lowering).
Vocal openness (Vowel quality)	Raises the tongue blade, which makes vowels higher (more close).	Lowers the tongue blade, which makes vowels lower (more open).
Phonation type	Produces deep pharyngeal quality (breathy, pharyngeal resonance).	Produces a more constricted voice quality (clear voice, laryngealized, pharyngealized rasp).

Gregerson considered onset voicing in Austroasiatic to be a by-product of tongue-root movement, along with other register properties. According to him, the advancement or retraction of the tongue root increases and decreases the volume of the vocal tract, respectively. These changes in vocal tract volume, in turn, facilitate or hinder vocal fold vibrations. Gregerson seemed to ignore the lowering of the larynx mentioned in many previous studies on register in the area as an additional strategy to enlarge the vocal tract in favour of onset voicing (§2.1.2). He did not consider the active control of vocal folds thickness and tension in producing closure voicing either.

Gregerson further linked tongue-root movement to f0 differences between registers by claiming that "an extreme tongue gesture can produce more glottal tension than a less extreme one and thus contributes toward greater vocal cord vibration" (1976, p. 355).

However, the link between tongue root configuration and f0 control, as far as I know, has not been experimentally confirmed.

In relating tongue movement and vowel quality, Gregerson explained how the low F1 property of high vowels results from movements of extrinsic tongue muscles as follows: "…[the] concavity in the lower pharyngeal region for high vowels causes an increase in volume in the posterior portion of the vocal tract and thus contributes to a lowering of the first formant frequency" (1976, p. 334). However, he did not mention that his proposed mechanism fails to acknowledge the fact that low vowels show a greater F1 decrease in the low register because their F1 depends on the back cavity volume to a larger extent than high vowels (cf. §2.1.3.1).

With regards to voice quality, Gregerson stated that an "advanced tongue-root produces an enlarged pharyngeal cavity, creating impressions of resonance focused in that region, while tongue-root retraction constricts the pharyngeal cavity, producing a reduced resonance there," and that, therefore, "deep pharyngeal qualities" and "more constricted effects" (1976, pp. 337-338) on voice quality develop in the two registers. However, he was not clear about the exact phonetic essence of voice qualities and seemed to ignore the role of the vocal folds and of the muscles and ligaments controlling them in producing different phonation types. Phonation is more than just resonance, and the author did not provide a convincing mechanism to link tongue root position to phonation.

Tongue root advancement was later experimentally proven to favour closure voicing. The involvement of the tongue root in voicing could obviously cause perturbations on the following vowel (Bell-Berti, 1975; Westbury, 1983; Ahn, 2018a, 2018b), but it alone cannot account for all register properties.

d. Ferlus (1979) – A typological and phonetic explanation of register

Ferlus (1979a) is an attempt at classifying sub-types of register and at providing a phonetic (in particular, articulatory) explanation for registrogenesis. Like most Austroasiatic scholars, he assumed that proto-Austroasiatic once had a voicing contrast in its onset stops, but that its daughters lost this contrast due to the loosening of the vocal folds and "laziness of articulatory organs" (1979a, p. 63) and transphonologized it into a register distinction. In his words, the various register systems in Mon-Khmer are all "possible compensatory responses to the progressive loss of the voice feature of initial stops" (1979a, p. 1).

Ferlus proposed to typologize Austroasiatic register systems into four groups based on their characteristic phonetic property (based on available descriptions at the time):

(i) *Breathy-voice* register – voice quality (mainly breathiness) is the salient cue, e.g., Mon.

(ii) *Vowel* register – vowel quality changes are the most salient cue:

- Vowel changes in the High register (< *voiceless stops): e.g., Brou, Khmer, High Lamet.
- Vowel changes in the Low register (< *voiced stops): e.g., Suoy, So, Kuoy, Low Lamet. (However, vowel changes could happen in both registers, with patterns that differ from language to language. General tendencies for these vocalic patterns are presented in Huffman (1985b))

(iii) *Melodic pitch* register – pitch height is the most salient cue: e.g., Riang, Kammu dialects, Tatey Khmer, Thavung (mixed with a breathy-voice register).

(iv) *Constrictive* register – constrictive tone (glottalization) is the most salient cue: e.g., Ong, Sedang, Chong-Pear, Todrah.

Ferlus then based himself on the phonetic investigation of the effects of voiced and voiceless initials on following vowels and on known articulatory mechanisms for the production of voicing (in particular, the lowering larynx movement) (Ladefoged, 1971; Hombert et al., 1979) to give an account of registrogenesis. According to him, when the devoicing of the voiced series happens, languages can take two directions to maintain their lexical contrasts: either transphonologizing the original voicing contrast into a new one (the first three types in the above grouping), or reinforcing/strengthening the voiceless series to keep a necessary phonetic distance between the two (leading to constrictive register).

For the first direction, Ferlus' explanation can be summarized as follows:

(i) *Pitch.* The difficulty of maintaining voicing in the production of voiced stops (the AVC (Ohala, 1983)) can be overcome by lowering the larynx[12], which results in a lower f0: "it follows a lowering of pitch that continues even at the beginning of the vowel emission" (1979a, p. 59). The exact mechanism for pitch lowering after voiced stops was not understood in 1979 and was only made clear by Honda et al. (1999).

(ii) *Breathy voice.* A greater quantity of air passes through the glottis because of the loosening of vocal folds.

(iii) *Closing prediphthongization (vowel quality).* The lowered larynx, in connection with oral muscles, "pushes the base of the tongue forward," enlarging the pharyngeal cavity, which consequently changes the resonances of vowel sounds. While an enlarged pharyngeal cavity does lower F1 (Trigo, 1991; Kingston et al., 1997; Ahn, 2018a, 2018b), Ferlus did not explain which oral muscle(s) is/are responsible

[12] Ferlus did not mention the other articulatory maneuvers that can overcome the AVC (see Section 2.1.2).

for simultaneously lowering the larynx and pushing the base of the tongue forward. In fact, it is likely that these gestures are both part of a general strategy to enlarge the supraglottal cavity rather than the consequence of the activation of a single muscle (or a group of coordinated ones). Note that Ferlus did not seem to be aware of the fact that a lengthened back cavity caused by larynx lowering can account for some of the vowel changes found in the low register.

If the second strategy (strengthening of the voiceless series) is employed to avoid the neutralization of voicing, languages can go in various directions:

(i) Increasing the tension (constriction) level of the voiceless series leads them to become aspirated (Haudricourt's "Germanic" type (1965)), in opposition to the original voiced series that now surfaces as plain voiceless: Phay, Tin, Khasi, and Chong-Pear.

(ii) The increased tension of the voiceless onset "floats down" and ends up on the following vowel or final consonant, creating constrictive register languages: Ong, Chong-Pear dialects, and Todrah.

(iii) The constriction of the voiceless onset moves to the pharynx area, creating a glottal-pharyngeal constriction before final consonants: Sedang.

(iv) The constriction can disappear and leave its trace in the opening prediphthongization of vowels by retracting the base of the tongue: Brou (vowels change in the high series).

Note that the second strategy is based on more limited descriptions than the first one and that it is neither systematically reconstructed nor phonetically motivated. However, because this second strategy is not relevant in Vietic, I will not dwell on it.

2.4 Periodization of tonogenesis and registrogenesis

We have seen so far that researchers use the term *tonogenesis* in two senses. The narrower sense of tonogenesis refers to the formation of tone from the loss of laryngeal contrasts in the codas, or more simply, from the loss of the glottal finals of -ʔ, -h/s, and other glottalized codas, in a previous atonal language. However, these glottal codas might not disappear at the same time or in the same order in different languages (Haudricourt, 1954b; Ferlus, 2004; Alves, 2018). The broader use of tonogenesis refers to all tonal developments occurring in a language, whether they stem from the loss of laryngeal contrast in onsets or codas, or in vowel height or vowel length contrasts (cf.§2.2.2). Among these processes, onset devoicing potentially results in the most diverse tonation systems (Haudricourt, 1965). It could lead to (i) the formation of register contrast, *registrogenesis,* as in multiple Austroasiatic languages*;* (ii) the doubling of the tone system, *tonal split*, if the language had already been tonal; or (iii) the formation of f0-based two tones tonal system. The rest of this section discusses the possible sequences in which tonal/registral developments can occur, with a focus on the Vietnamese tone system.

2.4.1 Does tone first develop from -ʔ or -h/-s?

In his tonogenetic model of Vietnamese, Haudricourt (1954b) did not explicitly or implicitly mention the relative order of the loss of the final glottals and simply described their effect on the pitch of the preceding vowel, which later developed into tone distinctions when these codas were dropped. He may have reasonably assumed that the codas were lost simultaneously, giving rise to a three-way pitch contour contrast (Table 2-2).

Ferlus (2004) proposed that the glottal stop -ʔ, or more precisely, the final glottal

constriction -ˀ, decayed first, followed by the final fricative:

> "Loss of laryngeal features in rhymes with - ˀ and – h [happened] in two phases. The first phase is the change of -ˀ into a pitch/contour melody, presumed rising and slightly constricted, that contrasts with -Ø in a two-tone system. The second phase is the loss of the laryngeal spirant -h, creating a third pitch/contour melody that contrasts with the two previous ones in a three-tone system." (2004, p. 298)

Ferlus suggested this scenario based on data from Vietic languages that show the loss of the glottal constriction -ˀ but not that of -h, leading to a contrast between glottalized and non-glottalized tones. After -ˀ is dropped, the final fricative is preserved in these languages without any indication of weakening. These two tones can then be split into four tones caused by onset devoicing, resulting in four-tone systems. Examples include the Vietic languages Rục (Nguyễn, 1993; Solntsev et al., 2001a; Tạ, 2021), Thavung (Ferlus, 1979b; Suwilai, 1996; Ferlus, 1998b), and Kri (Enfield & Diffloth, 2009).

Based on a comparison of Vietnamese with the Rục and Arem tonation systems, Koichi Honda (2005, 2008) also proposed that -ʔ was lost first in both Rục and pre-Việt-Mường, followed by the loss of -h in Việt-Mường but not in Rục. Honda differs from Ferlus (2004) in that he reconstructs register contrast at the Proto-Vietic level (more in the next section).

Gage (1976) advanced a contrary stance, that the final fricative -h was dropped first, which was followed by a neutralization of onset voicing that doubled the number of tones from two to four. He speculated that the glottal stop -ʔ was still present in B1/B2 tones after the tonal split caused by onset devoicing.

It seems that in languages that lost both final glottal stop -ʔ and fricatives -h/s, like Vietnamese, there is no definitive evidence to determine whether the former or the latter

happened first. Some tonal patterns in loans sometimes give indications on the periodization of tone development in the donor language. For example, Alves (2018) pointed out that a layer of Sino-Vietnamese with tone *ngang-huyền,* instead of *sắc-nặng*, for Middle Chinese *qusheng* suggests a short period when the final -h/s was lost before the drop of -ʔ in Middle Chinese. Unfortunately, there has not been any evidence of this type available for Vietnamese tonogenesis.

Variation between languages is possible, but available data suggest that the loss of -ʔ and glottalized codas normally precedes that of -h in Vietic, the opposite order to Chinese tonogenesis (Pulleyblank, 1978; Alves, 2018). The status of final laryngeals in representative Vietic languages will be discussed in the next chapter.

2.4.2 Onset devoicing or loss of laryngeal codas first?

Haudricourt (1954b) explicitly claims that in Vietnamese, the loss of laryngeal codas occurred first, forming a three-way tone contour contrast between level (< *-∅) vs. rising (< *-ʔ) vs. falling (< *-h/s) (tonogenesis). The voicing contrast in onsets was then neutralized, doubling the number of tones to six. According to Haudricourt's views, fully articulated in his 1965 paper, devoicing could not have led to tone formation in a language that did not have a pre-existing tone system but would rather have triggered a Mon-Khmer mutation, i.e. registrogenesis (we now know that two-tone systems derived from onset devoicing exist, such as Khmu, Lamet, and Danaw).

This coda-drop-first scenario was adopted by most later researchers, although some differed on points of fine-grained chronology and phonetic realization (Huffman, 1976; Diffloth, 1989a; Ferlus, 1998b; Thurgood, 2002; Ferlus, 2004; Alves, 2018).

As far as I know, Gregerson and Thomas (1976) were the first researchers to suggest that Vietnamese might have been a register language before the loss of its glottal codas. According to them, this register contrast arose in the same way as in most Austroasiatic languages and included a high vs. low pitch contrast (other registral cues such as phonation and vowel quality were not mentioned by Gregerson and Thomas). Therefore, the language would have started with a two-way tonal system and later split into six tones rather than the opposite.

Tonogenesis from onset devoicing is rare in Austroasiatic, being attested in a small number of languages only: Khmu (Premsrirat, 1999; Svantesson & House, 2006), Lamet (Lindell, Svantesson, & Tayanin, 1978), and Danaw (Luce, 1965). However, if one looks outside ESEA, one encounters this type of onset-derived tonogenesis in various genetically and geographically unrelated languages such as Malagasy (Howe, 2017) and Afrikaans (Coetzee et al., 2018). Although experimental work on these languages has focused on f0, available data suggest that they do not have complex register systems but rather have a two-way tone contrast exclusively based on f0. The question remains: what is so special about Austroasiatic languages that onset voicing in these languages was replaced by a bundle of phonetic properties, rather than just f0? Although I do not aim to answer this question in this dissertation, it is open for future studies.

Recently, Gehrman (2022) raised this possibility again, claiming it to be the normal tono-/registrogenetic mechanism in Austroasiatic languages and referring to it as the "OP-first" (onset phonation) hypothesis in contrast to the classical "CP-first" (coda phonation) hypothesis. Details of his hypothetic scenario of tone development in Vietnamese (involving a phonation split conditioned by vowel height) were already presented in

§2.2.2.2. Gehrman's main argument against the CP-first model is that there are no attested languages with three tones derived from glottal codas. The only possible cases are reconstructed languages, like proto-Hmong-Mien (Ratliff, 2002, 2010), proto-Tai (Gedney, 1986; Pittayaporn, 2009), Chinese and a few reconstructed Tibeto-Burman languages (Haudricourt, 1954a; Mei, 1970; Matisoff, 1973; Pulleyblank, 1973). No attested tone system is exclusively CP-derived.

2.4.3 An unsolved riddle: tonal correspondences in Sino-Vietnamese

Sino-Vietnamese primarily consists of loans from Old and Middle Chinese (OC and MC, hereafter). The two main layers of Sino-Vietnamese vocabulary are Early Sino-Vietnamese (ESV), which consists of loans borrowed between the periods of OC and proper MC (0~1000 CE), and Late Sino-Vietnamese (LSV), which was the administrative language of various Vietnamese dynasties between independence from China (the 10th century) and stabilized during the Late MC period in the 12th century (Phan, 2013; Alves, 2018). The phonological form of SV words depends on the phonology of both Vietnamese and Chinese at the time of borrowing. There are major differences in segmental and suprasegmental correspondences in Chinese and Vietnamese that are used to separate different SV layers, out of which tone correspondences are considered the most regular (Haudricourt, 1954b, 1954a; Sagart, 1999; Phan, 2013; Alves, 2018).

Accepted models of Chinese tonogenesis claim that the final glottal stop -ʔ and fricative -s had the same original tonogenetic effects as in Vietnamese. The glottal stop gave rise to the *shangsheng* tone (rising tone, also referred to as tone category B), final -s/-

h to the *qusheng* tone (departing tone, tone category C), and open syllables to the *pingsheng* tone (level tone, tone category A) (Haudricourt, 1954a; Mei, 1970; Pulleyblank, 1973, 1978; Sagart, 1986, 1999). In ESV, *pingsheng* was borrowed with Vietnamese A1/A2 tones, *shangsheng* with B1/B2 tones, and *qusheng* with C1/C2 tones (A to A, B to B, and C to C). The usual explanation for these correspondences is that neither language had tones and that laryngeal codas were still present in both when ESV words were borrowed. Chinese words were thus borrowed into Vietnamese with these codas, and the two languages later underwent tonogenesis independently, giving rise to the expected tones and tonal correspondences.

In LSV, *pingsheng* still corresponds to A1/A2 tones, but there is also a reversal of tone correspondence where *shangsheng* corresponds to SV C1/C2 tones and *qusheng* to SV B1/B2 tones. The changes in tone correspondences between ESV and LSV are summarized in Table 2-18 and exemplified in Table 2-19.

Table 2-18. Tone correspondences in Sino-Vietnamese layers.

Old Chinese – Early Middle Chinese	*Early Sino-Vietnamese*	*Late Middle Chinese*	*Late Sino-Vietnamese*
pingsheng →	A tones (*ngang/huyền*)	pingsheng →	A tones (*ngang/huyền*)
shangsheng →	B tones (*sắc/nặng*)	shangsheng	B tones (*sắc/nặng*)
qusheng →	C tones (*hỏi/ngã*)	qusheng	C tones (*hỏi/ngã*)

Table 2-19. Examples of tone category changes between ESV and LSV (Alves, 2018, p.16).

GLOSS	CHIN	OC	MC	ESV	LSV
A. *hỏi* versus *sắc* (B1 vs. C1) – differing segments					
to marry	嫁 jià	*s.kˁra-s	kaeH	**gả**	giá
age	歲 suì	*s-qʷʰat-s	sjwejH	**tuổi**	tuế
measure for divinations	卦 guà	*[k]ʷˁre-s	kweaH	**quẻ**	quái
B. *ngã* versus *nặng* (B2 vs. C2) – differing segments					
word (in writing)	字 zì	*mə-dzə-s	dziH	**chữ**	tự
chopsticks	箸 zhù	*d<r>ak-s	drjoH	**đũa**	trợ
hat	帽 mào	*mˁuk-s	mawH	**mũ**	mạo
C. *ngã* versus *nặng* (B2 vs. C2) – the same segments					
two	二 èr	*ni[j]-s	nyijH	**nhĩ**	nhị
think	議 yì	*ŋ(r)aj-s	ngjeH	**nghĩ**	nghị
D. *Sắc* versus *hỏi* (C1 vs. B1) – differing segments					
noodles	粉 fěn	*mə.pənʔ	pjunX	**bún**	phấn[13]
lord	主 zhǔ	*toʔ	tsyuX	**chúa**	chủ
paper	紙 zhǐ	*k.teʔ	tsyeX	**giấy**	chỉ
E. *Sắc* versus *hỏi* (C1 vs. B1) – the same segments					
light, glare	影 yǐng	*qraŋʔ	jaengX	**ánh**	ảnh
rather, very	可 kě	*[k]ʰˁa[j]ʔ	khaX	**khá**	khả
to order/bid	遣 qiǎn	*[k]ʰe[n]ʔ	khjienX	**khiến**	khiển
F. *nặng* versus *ngã* (C2 vs. B2) – differing segments					
father's younger brother	舅 jiù	*[g](r)uʔ	gjuwX	**cậu**	cữu
net	網 wǎng	*maŋʔ	mjangX	**mạng**	võng
to wait	待 dài	*[d]ˁəʔ	dojX	**đợi**	đãi
G. *nặng* versus *ngã* (C2 vs. B2) – the same segments					
to receive, acknowledge	*rěn	*nə[n]ʔ	nyinX	**nhận**	nhẫn
cold	冷 lěng	NONE	NONE	**lạnh**	lãnh

Sagart (1986) was the first to tackle this tone reversal, and he hypothesized that length was the determining factor in assigning Vietnamese tones to SV elements. According to him, *pingsheng* always matched A1/A2 tones as they were long tones with clear phonation in the two languages. The shortest tone of MC, *qusheng,* matched with B1/B2, two short tones in Sino-Vietnamese. *Shangsheng*, a tone with medium duration, was matched by the remaining C1/C2 tones. Phan (2013) recently revised this thesis by claiming that three-way length should be posited for both Chinese and Vietnamese tone

systems, by which *pingsheng* and A1/A2 are longest, *shangsheng* and C1/C2 tones are medium and *qusheng* and B1/B2 are shortest (Figure 2-7).

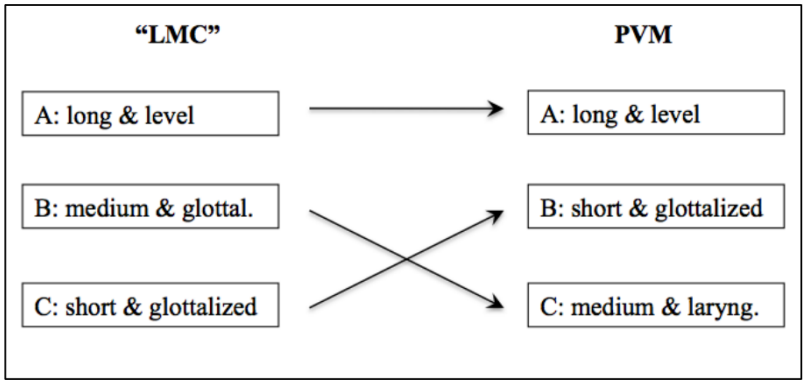


Figure 2-7. Phan's revision to Sagart's (1986) explanation of tonal patterns in Late Sino-Vietnamese.

Although length is an important phonetic property of tone systems in the area, a three-way length contrast is phonologically unlikely and has not been established in production and perception studies. Furthermore, neither Sagart nor Phan explained how the laryngeal finals -ʔ, -h/s would have come to condition different rhyme durations in the two languages. It has to be mentioned that both authors took into account the different phonations (voice qualities) associated with the various tones. However, they only considered them as secondary and were not very specific on what their use of *glottalized* and *laryngealized* refers to phonetically. The data from Rục and Arem in this dissertation will shed some light on this long-standing puzzle, and I will go back to this in Chapter 7.

2.4.4 Could phonation be the source of both register and tone?

Thurgood (2002) claimed that onset devoicing necessarily causes the development of a phonation distinction (usually between a modal and a breathy phonation) and that this phonation distinction is the necessary source of both registrogenesis and tonal split.

According to him, the tone split that occurred in Vietnamese and other tone languages was not directly caused by onset devoicing but was instead mediated by a phonation distinction, in which a breathy phonation was accompanied by a lower pitch and a modal phonation by a higher pitch. This pitch difference was phonologized when the phonation difference faded, doubling the number of tones. In register languages, the same phonation distinction was responsible for the development of pitch and vowel quality distinctions. In effect, Thurgood's model implies that registrogenesis and tone split are two facets of the same process and negates the distinctness of the three types of outcomes of onset devoicing laid out in Haudricourt (1965). However, Thurgood did not explicitly mention if the by-products of changes to phonation and vowel quality are expected to remain in tone systems after the completion of the tone split, specifically in Vietnamese, the focus of the paper (Thurgood, 2002).

Thurgood's hypothesis on phonation-conditioned pitch and vowel quality differences is indeed attested in several languages. Studies have confirmed that a phonation contrast is sometimes present when a pre-existing tone system is doubled due to onset devoicing. One representative case is Tamang, a Tibeto-Burman language (Mazaudon & Michaud, 2008). In this language, the onset devoicing led to the doubling of the two tones into a four-tone system, in which the two low tones (< *voiced onsets) are realized with a lower pitch and a breathier phonation than the two high tones (< *voiceless onsets) and preserve remnants of closure voicing. Mazaudon and Michaud (2008) presented Tamang as a "missing link" in tonogenesis that attests the "transitional" stage between onset voicing and tonal bipartition. Similar to Tamang, Rục also has a breathy phonation in its low tones (Nguyễn, 1993; Solntsev et al., 2001a; Tạ, 2021). However, the co-existence of a robust breathy

phonation and register-conditioned vowel changes in Rục raises doubt about Thurgood's claim on the *direct* causation link between phonation and vowel changes. These two phonetic properties might both be consequences of articulatory maneuvers mobilized to overcome the AVC (§2.1.2).

Vowel changes accompanied by a tonal split conditioned by onset devoicing are rare, but they are attested in a handful of languages. A fairly transparent case is the Fuzhou Chinese dialect, which has "register-based" tone-vowel interactions (Donohue, 2017). In this dialect, tones with creaky phonation (set B) co-occur with a set of more open vowels and rising diphthongs than tones with modal phonation (set A in Table 2-20). One can see that vowels in set B show the same tendency for lowering as those in the Austroasiatic High register (Huffman, 1976; Ferlus, 1979a; Huffman, 1985b). Two other examples include the West Hmongic language Zongdi (Ratliff, 2010) and Rục (Vietic) (Nguyễn, 1993; Solntsev et al., 2001a; Tạ, 2021).

Table 2-20. Tone-Vowel pairs in Fuzhou (from Donohue, 2017: 101).

Set A: **Tones 1 [44], 2 [32], 5 [51], 7 [5]**	**Set B:** **Tones 3 [21], 4 [13], 6 [231]**
i	ei
ei	ai
u	ou
ou	au
y	øy
øy	œy
a	a

Except for the languages mentioned above, there have not been many descriptions of consistent registral cues, such as phonation and vowel quality, in tone groups after tonal splits. In Vietnamese, some authors mention the presence of breathy voice quality in tone

A2 as a remnant of the low register (< *voiced) to which this tone diachronically belongs (Edmondson & Lợi, 1997; Pham, 2004). However, this phonetic property is inconsistent across speakers and dialects (Vũ, 1981, 1982; Brunelle, 2009). In Chapter 6, I will investigate possible register-based phonation type and vowel quality distinctions in three North-Central Vietnamese dialects and show that such distinctions are limited at best.

While I have no intention of denying that there are phonetic and diachronic similarities between registrogenesis, tonal split, and related processes, my goal in this dissertation is to show that these processes can combine and interact in multiple ways to yield a wide range of synchronic outcomes, even among the Vietic languages themselves. More generally, I aim to investigate common and language-specific (and even dialect-specific) properties of tone and registers in the Vietic family in order to assess what is likely and what is unlikely in tonogenesis and registrogenesis generally.

Chapter 3

Vietic languages

This chapter is on Vietic languages, the topic of this dissertation. In **3.1**, I first introduce the Vietic languages that have been identified up to now; then, I present a short history of the classification of Vietic languages. In **3.2**, I provide a description of the tonation systems in Vietic languages. This section largely follows Ferlus (1998b), updated with information which was not available back then. The chapter ends with a summary of previous reconstructions of Proto-Vietic in **3.3**.

3.1 Vietic as a family of the Austroasiatic phylum

3.1.1 The discovery of a language family and its taxonomy

Austroasiatic speakers occupy a vast area that stretches from eastern India to Southeast Asian countries like Myanmar, Thailand, Laos, Cambodia, Vietnam, Southern China, and the Malay peninsula (Diffloth & Zide, 1974; Parkin, 1991; Sidwell, 2014b). Although researchers have not reached a consensus on the internal taxonomy of the phylum, thirteen branches

have been identified: Munda, Khasian, Aslian, Nicobarese, Palaungic, Khmuic, Vietic, Katuic, Monic, Khmeric, Bahnaric, Pearic, and Pakanic (Sidwell, 2014a). Their geographical distribution is represented in Figure 3-1.

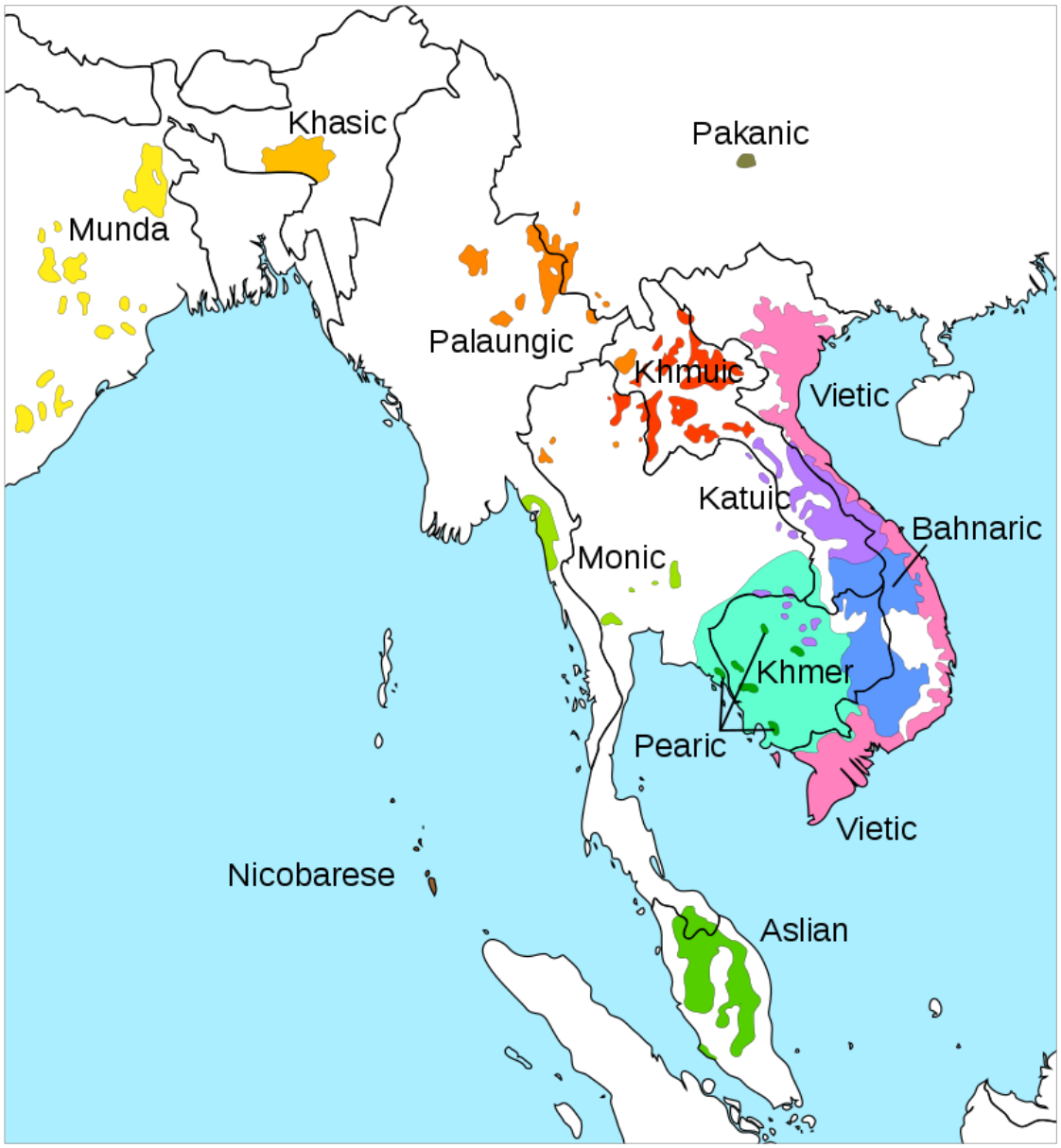


Figure 3-1. Distribution of Austroasiatic languages today (reproduced from Sidwell 2009).

The discovery of the Austroasiatic phylum dates back to Logan (1851), who suggested a possible language stock in Southeast Asia based on shared isoglosses between

Annamese (Vietnamese) and Basisi, which is nowadays known as the Mah Meri language of the Aslian group (Benjamin, 1976; Kruspe & Hajek, 2009). In 1856, based on additional evidence from Mon (Talaeng) taken from Manson (1854), Logan officially coined the name *Mon-Annam* for his proposed phylum (Logan, 1856). Work by scholars over the following century and a half started to reveal the internal grouping of the phylum, although the most recent study based on "lexical, lexicostatistical, computational phylogenetic, and phonological studies" (Sidwell, 2014a, p. 179) suggest that the language tree has a relatively flat structure: almost all branches branch out parallel from their Austroasiatic origin (Figure 3-2). For an in-depth history of the classification of the phylum and its branches, readers are referred to Sidwell (2009).

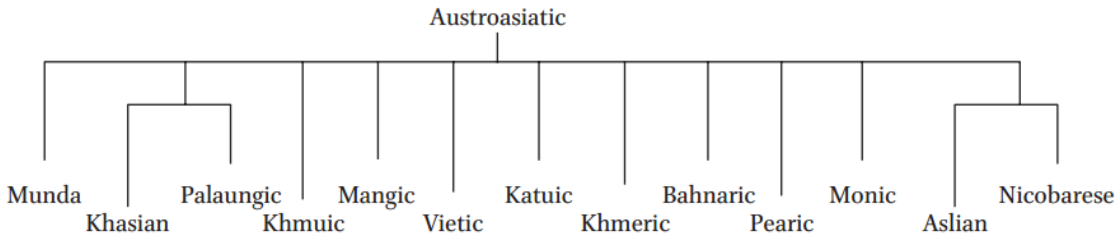


Figure 3-2. The Austroasiatic tree (Sidwell, 2014a, p. 179).

As shown above, the Vietnamese language has played a crucial role in research on the Austroasiatic phylum from the very beginning of this tradition. Around 1905, French scholars began to describe Mường and its dialects, whose population extended from the Hoà Bình province in Northern Vietnam to Quảng Bình province in North-Central Vietnam (Cadière, 1905; Chéon, 1905, 1907). The language was shown to be closely related to Vietnamese and was used in a study of the history of Vietnamese initials soon thereafter (Maspero, 1912). Then, the languages of many small populations of the region were discovered and documented and were assumed without question to be different dialects of

Mường. Only much later were they confirmed to be separate languages from Vietnamese and Mường. These include Sắc (Chéon, 1907) and Tắc-Củi (Guignard, 1911), later known as the Sách and Rục dialects of the Chứt language; Hung and Không-Khênh (Guignard, 1907), two dialects of the Pọong language; and Mường Lâm La, Mường Như Xuân, Mường Làng Lỡ (Maspero, 1912) which are dialects of the Thổ (or Cuối) language. Various terms were coined to designate the linguistic group to which all these languages belong, based on combinations of the name *Mường* and of different names of Vietnamese: *Annam-Mường, Mường-Annam, Annamese-Mường, Annamường,* and *Việt-Mường* (Barker, 1963, 1966; Barker & Barker, 1970; Thomas & Headley, 1970; Thompson, 1976).

In the 60s and 70s, more and more related languages and dialects were uncovered in the vicinity of the border between Laos and Vietnam thanks to research by Vietnamese, Soviet, and French linguists: Rục, Mày, Arem, Tày Pọong, Mã Liềng, Kha Phong, Thổ, Cuối (Lã et al., 1959; Vương, 1963; Mạc, 1964), and Thavung (Ferlus, 1979b). At that time, the name *Việt-Mường* was still used, but it caused confusion as to whether it referred to the whole family or to one of its subbranches that included only Vietnamese and Mường. This situation led Hayes (1982) to introduce the name *Vietic* for the entire family and to limit *Việt-Mường* to the designation of Vietnamese and Mường (Hayes, 1982, 1984, 1992). Vietnamese researchers also developed the term *Việt-Chứt* to refer to Vietic (Nguyễn, 1995). Recently, Chamberlain (2018) proposed a new term *Kri-Mol* as the family name, with Kri being a Maleng dialect in Laos recently described (Enfield & Diffloth, 2009) and Mol (Vietnamese *Mọn*) being a Mường dialect. In this dissertation, I use *Vietic* to designate the Austroasiatic group that includes Vietnamese, Mường and the smaller related languages spoken in Central Vietnam and Laos. It is worth noting that Vietic has been proposed to

have a relatively close connection with Katuic and that the two families form a Vieto-Katuic node in most proposed Austroasiatic language trees, a hypothesis supported by lexical evidence and shared phonological innovation (Diffloth, 1989a, 1992; Nguyễn, 1995; Alves, 2005; Diffloth, 2005).

3.1.2 Vietic languages and their classification

The large number of language and dialect names (including their spelling variants) that are used in the literature on Vietic languages can be quite disorienting. This section thus avoids this confusion by introducing Vietic languages and their dialects without discussing their connections, based on a list established by Ferlus (1996) and additional data that was not available back then. I then introduce different classifications of Vietic languages that previous scholars have proposed.

3.1.2.1 Vietic languages

Ferlus (1996) divided Vietic languages and dialects into eight subgroups, the first being the most conservative and the eighth being the most innovative languages. The criteria for this initial dichotomy between conservative and innovative languages are based on basic vocabulary and phonetic particularities. Ferlus chose a representative language name for each subgroup and provided a list of all the dialects they contain (and their multiple names). It seems reasonable to assume that each of Ferlus' eight subgroups corresponds to a language with different dialects, but whether two given Vietic dialects are linguistically far enough to be considered distinctive languages calls for further studies and is beyond the scope of this dissertation.

The relative distribution of the eight Vietic languages and their dialects are given in Figure 3-3. The eight subgroups of Vietic languages, according to Ferlus (1996), are as follows:

1. Maleng
2. Arem
3. Chứt
4. Aheu
5. Hung
6. Thổ
7. Mường
8. Vietnamese

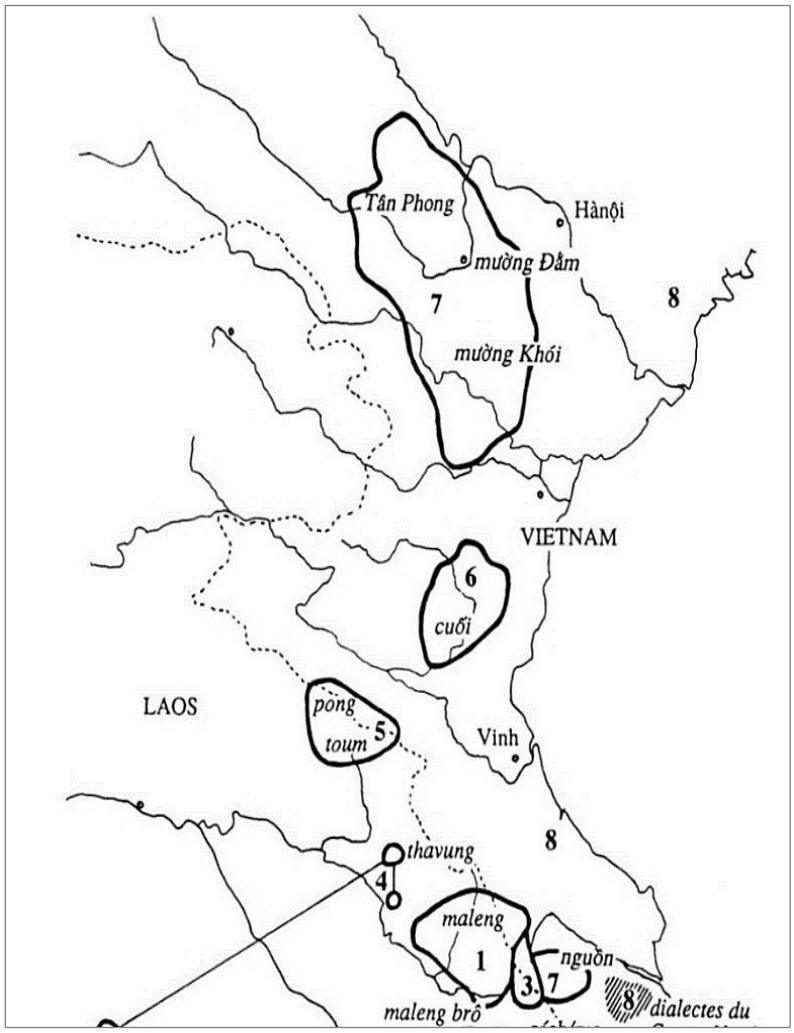


Figure 3-3. Distribution of Vietic languages by Ferlus (1998b, p. 27).

1. Maleng is composed of three dialects:

- Maleng, (Kha) Pakatan, Malang, Hareme (Rivière, 1902b). *Other names*: Kha Muong Ben and Kha Bo (Fraisse, 1949b, 1950). These dialects are spoken in Laos, and their cumulative population does not exceed 1,000.
- Malieng (Vietnamese Mã Liềng). *Other name*: Pa Leng (Đặng, Chu, & Lưu, 1986). This dialect is spoken in several villages in the Hà Tĩnh and Quảng Bình provinces in Vietnam. It has about 200 speakers.
- Kha Phong, Maleng Kari, Maleng Bro. *Other names*: Kha Nam Om (Fraisse, 1949a) for Maleng Bro, and Kri Phoongq/Kri Phọong for Kha Phong. Their total population was estimated not to exceed 250-300 people (Babaev et al., 2021).

Two other dialects of Kri and Phoongq spoken in Laos could be added to the Maleng group, although their relation to other Maleng dialects has not been investigated yet (Chamberlain, 2003; Enfield & Diffloth, 2009).

2. Arem is a language spoken in one village located deep inside the Phong Nha-Kẻ Bàng National Park in Quảng Bình, Vietnam. Nowadays, less than ten people can still speak it (more details in Chapter 4). *Other names*: Chomrau / Chombrau, Umo (Đặng et al., 1986).

3. Chứt is composed of Sách, Mày, Rục, and Salang dialects. *Other names*: Tắc-Củi (Guignard, 1911) for Rục, Kha Mụ-giạ (Fraisse, 1950) for Sách and Salang, and Sắc (Sắk) (Cadière, 1905; Chéon, 1907; Maspero, 1912) for Sách. Sách (in Vietnam) and Salang (in Laos) are closely related and straddle the Vietnam-Laos border that is naturally marked by the Mụ-giạ pass. Note that in Vietnam, Chứt is used as the official name for the ethnic group that includes not only Sách, Mày, and Rục, but also Arem and Mã Liềng. The population

of Chứt language-speaking communities, excluding Arem and Mã Liềng, is approximately 7,000 (Ủy-ban & Thống-kê, 2020).

4. Thavung (Ferlus's Aheu) has two branches:

- (Kha) Thavung, Aheu, (Kha) Phon Soung. *Another name*: Kha Tong Luang. Aheu and (Kha) Phon Soung are two autonyms used for dialects of Thavung. Aheu is an exonym which means "who?" and is used by other people when they meet the Thavung. This branch is spoken in Laos by 200-300 people.
- So (Thavung) is spoken by about one thousand people in the Songdao district of Sakonnakorn province in Northeast Thailand. Their ancestors migrated from Laos about one century ago (Suwilai, 1996).

5. Poọng (Ferlus' Hung) includes two dialect groups:

- Pọng (Pọong)/Phong, Tay Pọng. *Other names*: Hung and Không Khênh (Guignard, 1907), Xá Lá Vàng (Đặng et al., 1986) for Pọng, K'katiam-Pong-Houk (Macey, 1907) for Phong. Pọng or Tày Pọng is spoken by more than 700 people in Tương Dương district, Nghệ An province, Vietnam. Phong is spoken in Laos by an unreported number of speakers.
- Toum, Đan Lai, Ly Hà. Đan Lai and Ly Hà are varieties spoken in the Con Cuông district, Nghệ An province, while Toum is on the Laos side. Groups of Ly Hà people were also reported in Laos but originally originated from the Nghệ An-Khamkeut border (Chamberlain, 2003).

6. Cuối (Ferlus' Thổ) is composed of several dialects: Thổ, Cuối, Cuối Chăm/Cuối Tẻ, Cuối Đếp/Cuối Nếp. These dialects are spoken in Vietnam by around 30,000 people. Other

dialects, such as Kẹo, Họ, and Mọn, were once considered to belong to Thổ but are now recognized as dialects of Vietnamese and Mường (Nguyễn, 2009b).

I choose the name Cuối rather than Thổ, as the latter is used by Vietnamese authorities to designate an ethnic category that subsumes different Vietic languages and dialects, including Vietnamese, Mường, and Pọong (Nguyễn, 2009b). This is also to avoid unnecessary confusion with a Tay (Kra-Dai) language-speaking group in the Cao Bằng province, Vietnam.

7. Mường has other names like Mol, Mọn, Mual. It is the fourth largest ethnic group of Vietnam, with a population approaching 1.5 million (Ủy-ban & Thống-kê, 2020). The language is composed of various dialects, usually differentiated by the name of their locations. Recently, Phan (2012) suggested that Mường dialects do not form a subgroup, but are instead several different language varieties that form a subgroup that also includes Vietnamese. Ferlus (1996) also considers Nguồn as a Mường dialect whose people would have moved to Quảng Bình from Thanh Hoá in the 17th century. However, the exact relationship between Nguồn, on the one hand, and Mường and Vietnamese, on the other, has not been settled (Nguyễn & Barker, 1993; Nguyễn, 2009a; Sidwell & Alves, 2021b).

8. Vietnamese (also Việt, Kinh, and Annamese). Vietnamese is the national language of Vietnam, with more than 82 million native speakers in 2019 (Committee, 2019). It is generally divided into three major dialectal regions, Northern, Central, and Southern Vietnamese (Hoàng, 2004), but the Central group does not constitute a homogeneous group by linguistic standards. The North-Central dialects, which extend from Thanh Hoá province to the north of Quảng Bình province, are considered the most conservative

Vietnamese varieties and retain many archaic phonetic and phonological features.

Since Ferlus' (1996) extensive description of the Vietic people and languages, many minor dialects have been discovered on the Laos side, but they are all undocumented and awaiting proper linguistic investigations, except for Kri (Enfield & Diffloth, 2009). These include Arao, Atel, Atop, Ahao, Ahlao, Thémarou, To'e, Kata, and Makang (Chamberlain, 2003, 2018, 2020) (Figure 3-4). Despite the lack of proper linguistic descriptions, these varieties are already incorporated into the list of Vietic languages and dialects used for monitoring data collection and archives in the Mon-Khmer Languages Project (http://sealang.net/monkhmer/) (Table 3-1). Note from this table that Vietic languages are divided into three subbranches according to their geographic distribution and that eleven distinct languages are proposed (Bo, Kri, and Nguồn have been added to the languages listed in Ferlus' (1996)). One should consult this language classification with care, as there is no explicit explanation for its language/dialect determinations and grouping. For example, the proposed Bo language (ISO code *bgl*) is under question, as it is another name for (Kha) Pakatan, a Maleng dialect.

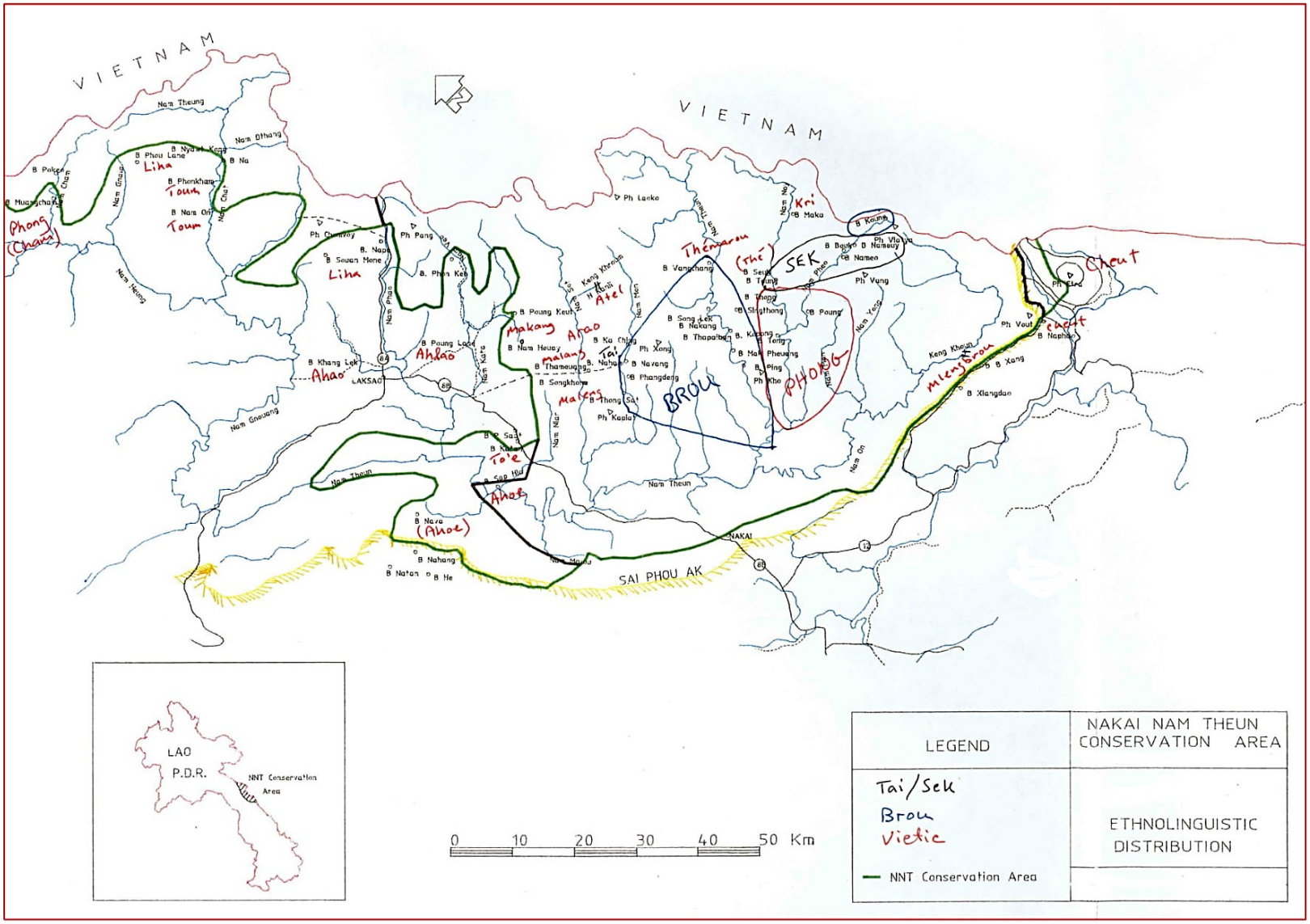


Figure 3-4. Distribution of Vietic languages on the Nakai plateau in Laos (reproduced from Chamberlain, 2020, p. 1596).

Table 3-1. Language grouping of the Vietic family in the Mon-Khmer Languages Project (http://sealang.net/monkhmer, retrieved 2nd October 2022).

Sub-branch | Sub-branch alternate	**Language (L) | Language alternate (LA) | Dialect (D) | Dialect alternate (DA) | Language pejorative (LP)**	**ISO code**
Central Vietic | Pong-Chut	Pong (L) | Phong (LA) | Poong (LA) | Liha (D) | Ly Hà (DA) | Toum (D) | Tum (DA) | Hung (D)	hnu
	Tho (L) | Thổ (L) | Cuối (D) | Cuoi (DA) | Cuoi Cham (DA)	tou
	Arem (L) | A-Rem (LA) | Chomrau (LA) | Chombrau (LA) | Umo (LA)	aem
	Bo (L)	bgl
	Chut (L) | Chứt (LA) | Sách (D) | Rục (D) | Mày (D)	scb
	Kri (L) | Maleng Kri (LA) | Krìì (LA) | Sô Salang (LA) | Harème (LA) | Kha Phong (D) | Phóng (DA) | Phòòngq (DA) | Maleng Brô (D) | Mlengbrou (DA)	scb
	Maleng (L) | Malieng (LA) | Mã Liềng (LA) | Malang (D) | Pakatan (DA) | To'e (DA) | Hareme (DA) | Arem (DA) | Atel (D) | Arao (D) | Thémarou (DA)	pkt
East Vietic | Viet-Muong	Muong (L) | Mương (LA) | Thang (D) | Wang (D) | Mol (D) | Mon (DA) | Mual (DA) | Moi 1 (D) | Boi Bi (D) | Moi Bi (DA) | Ao Tá (D) | Au Tá (DA)	mtq
	Nguon (L) | Nguồn (LA) | Ngouan (LA)	nuo
	Vietnamese (L) | Kinh (LA) | Annamese (LA) | Annamite (LA) | Northern Vietnamese (D) | Tonkinese (DA) | Hanoi Vietnamese (DA) | Central Vietnamese (D) | Hue Vietnamese (DA), Southern Vietnamese (D) | North Central Vietnamese (D) | Vinh Vietnamese (DA)	vie
West Vietic	Thavung (L) | So Thavung (LA) | Sotawueng (LA) | Ahlao (LA) | Ahao (D) | Aheu (D) | Phôn Soung (DA) | Phonesoung (DA)	thm

3.1.2.2 Classifications of Vietic languages

As early as 1966, lexicostatistical analysis was employed to establish subgroupings among the Austroasiatic and Vietic languages (Thomas, 1966; Thomas & Headley, 1970). In their lexicostatistical analysis, Thomas and Headley (1970) used the first available wordlists of minor Vietic languages discovered in Central Vietnam, such as Mày, Rục, Arem, Tày Pọong (Vương, 1963; Mạc, 1964) to group these languages within the Việt-Mường language branch, which at that time included only the Vietnamese and Mường languages. Thomas and Headley extended the term *Việt-Mường* to include all the sister languages of Vietnamese and Mường.

The first explicit classification of Vietic languages appeared in Ferlus (1979b) (see Figure 3-5), along with a lexical list and a short description of the phonological system of Thavung that Ferlus had assembled in the Khammouan province (Laos) in 1965-1970. In this classification, three groups of Thavung and two other Vietic varieties, Pakatan-Phon Soung (Chứt) and Pong-Toum, constitute a conservative southern branch, while Vietnamese, Nguồn and Mường form a branch that has undergone strong Chinese influence (even if Nguồn is geographically closer to the conservative languages).

Hayes (1992) proposed a new grouping of Vietic languages, but with neither newly added data compared to Ferlus (1974, 1979b) nor family-internal branching (Figure 3-6). This grouping was primarily driven by the geographic distribution of the languages and dialects, as the names of its three subgroups indicate (West, Central, and East Vietic). Hayes did not provide definite language names for the West and Central Vietic branches, but he listed all dialects known at that time.

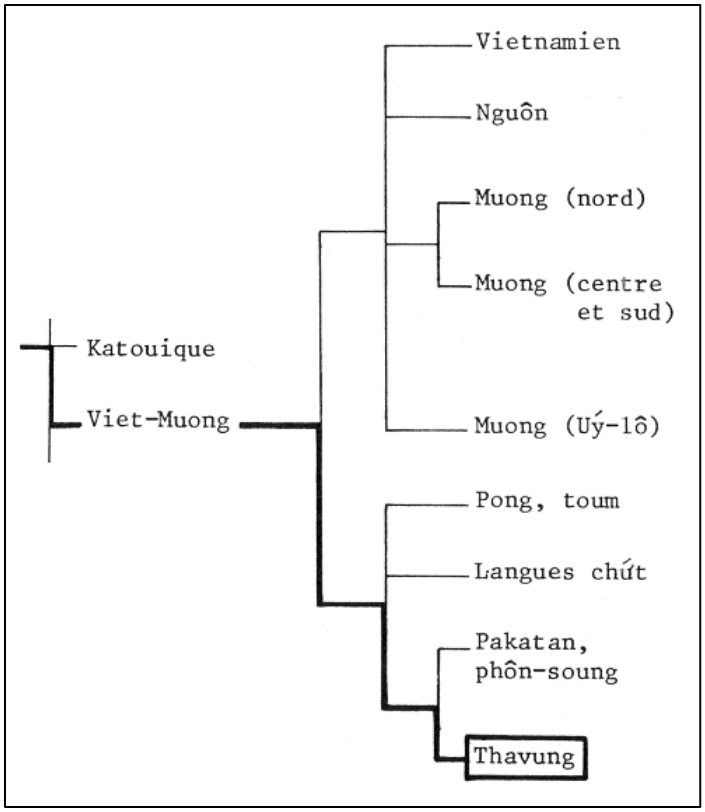


Figure 3-5. Vietic classification, with the highlighted position of Thavung (Ferlus 1979: 81).

1. West Vietic.
- 1.1. Thavưng (Kha Tha Vưng).
- 1.2. Kha To(o)ng Luông, Phon Soung (Phôn Xúng).
- 1.3. Kha Bô, Kha Mường Ben (Bên), Kha Nặm Ớm, Pakatan.
- 1.4. Harème, Kha Phọng.

2. Central Vietic.
- 2.1. Đan Lai, Katiam Pong Houk, Ly Hà, Tà P(o)ọng.
- 2.2. Hung, Không Khêng
- 2.3. Toum (Tày Túm, Ktum).
- 2.4. Cọi, Cuối, Tày Chăm, Tày Pụm.

3. East Vietic.
- 3.1. Chứt.
  - 3.1.1. Arem, Mã Liềng, Mày, Rục, Sách.
  - 3.1.2. Kha Mụ Già
- 3.2. Viet–Muong.
  - 3.2.1. Mường–Nguồn.
    - 3.2.1.1. Mường dialects.
    - 3.2.1.2. Nguồn.
  - 3.2.2. Vietnamese.
    - 3.2.2.1. Centrolineal dialects (Hanoi, Huê, Saigon, etc.)
    - 3.2.2.2. Archaic dialects (Haut Annam).

Figure 3-6. Vietic languages by Hayes (1992, pp. 220-221).

Nguyễn (1993) provided some insights into the subgrouping of Vietic languages of Vietnam with a lexical comparison between Vietnamese, Mường, Pọong, Rục, and Arem with several Katuic languages (Figure 3-7) based on the Swadesh list of 100 basic words. For example, Pọong is equally distant from Vietnamese (51.5% shared cognates), Mường (50.5%), Rục (52%), and Arem (51.5%), suggesting that Pọong is an intermediate variety, connecting/bridging Vietnamese with the other Vietic languages. Arem is also closer to Rục (66.5%) than any of the other three Vietic languages, suggesting that Rục and Arem form a subbranch in the East clade of the Vietic family (Peiros, 2004; Sidwell & Alves, 2021b). The fact that Arem shares a higher percentage/proportion of cognates with Katuic languages, Pakoh, Taôih, and Bru, than any other Vietic languages do is because of Katuic loans into Arem: Arem people intermarry and have long been in close contact with neighbouring Katuic groups, but not with other Vietic groups.

						Taôih	Bru
					Pakoh	71	72
				Arem	40	38	41
			Rục	66,5	37,5	33	37,5
		Pọong	52	51,5	35,5	33	35
	Mường	50,5	50	56,5	27	26,5	31,5
. Việt	74	51,5	53	45	26	24	29,5

Figure 3-7. Lexical comparison between Vietic languages and Katuic languages (Nguyễn Văn Lợi 1993: 22).

A subgrouping of Vietic languages, or more precisely of Vietic-speaking groups, by geographic locations was also conducted by Chamberlain (2003, 2020) with more detailed divisions than Hayes (1992), as shown in Figure 3-8. This classification is flat; all subgroups derive from the same ancestor. This is because little to no linguistic data was considered in building the language tree. Chamberlain also proposed a more elaborate

classification of Vietic languages (2018), reproduced in Figure 3-9. Unfortunately, this classification suffers from a lack of adequate linguistic evidence. The Malieng dialect under Toum-Ruc class of the Mol-Toum clade should be classified together with Malang, Maleng, and Pakatan languages. Arem, a distinct Vietic language, was also overlooked and not included in the language tree, possibly because Chamberlain treated it as a part of Cheut (Chứt), the class that includes Rục, Mày, Sách, and Mã Liềng dialects.

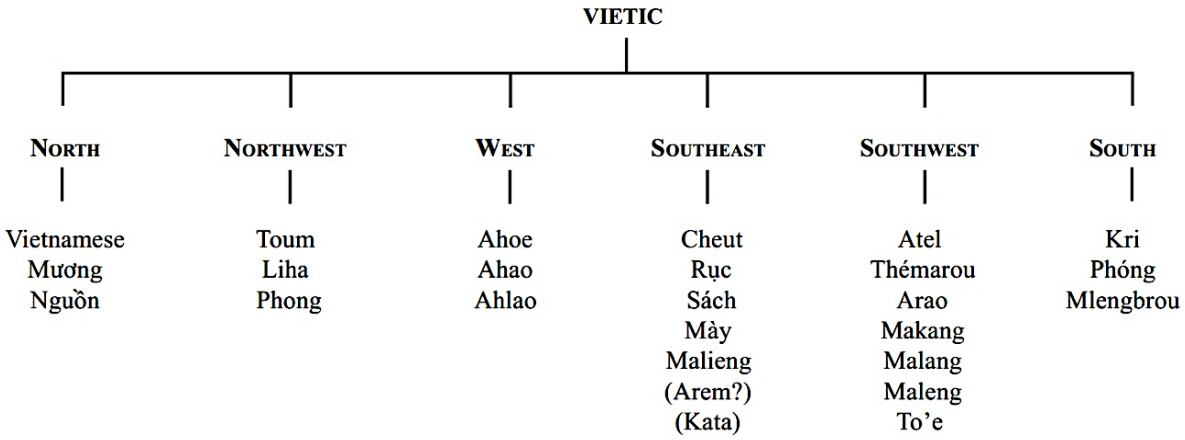


Figure 3-8. Classification of Vietic languages by Chamberlain (2003, 2020).

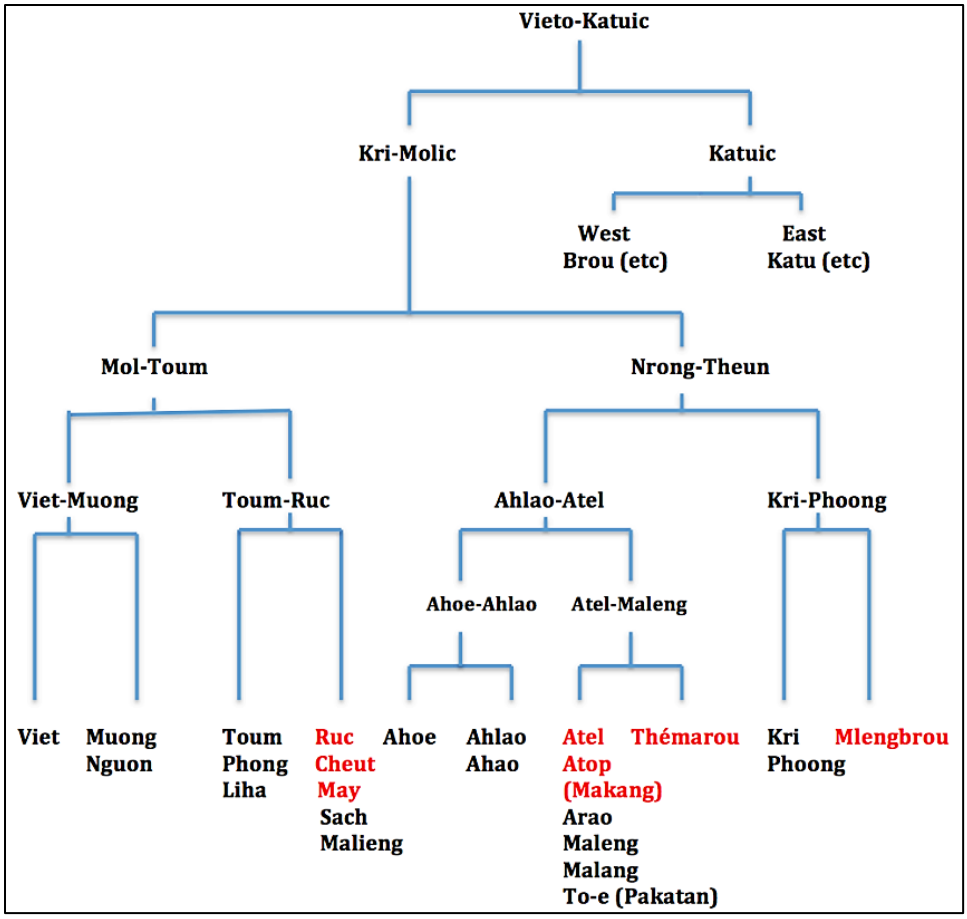


Figure 3-9. Classification of Vietic languages by Chamberlain (languages whose speakers have recently been practicing semi-nomadic lifestyle are marked in red) (2018, p. 12).

Peiros (2004) used the Starling software to analyze thirteen representative Vietic dialects, which resulted in the hierarchy given in Figure 3-10. The data used was limited to 100 basic lexical items. Thavung (in Laos and Thailand) splits from languages spoken in Vietnam and Laos at the root. In one clade, Malieng and Kha Phong are grouped together and are considered distinct from all others. In the other clade, Rục and Arem are divided from the rest, which is in line with previous studies. Cuối and Pọong dialects, Phong, Toum, and Liha, form a group sharing the same node with Việt-Mường languages. Later studies with more abundant data have since shown that Cuối is closer to Việt-Mường languages than to Pọong (Sidwell & Alves, 2021b).

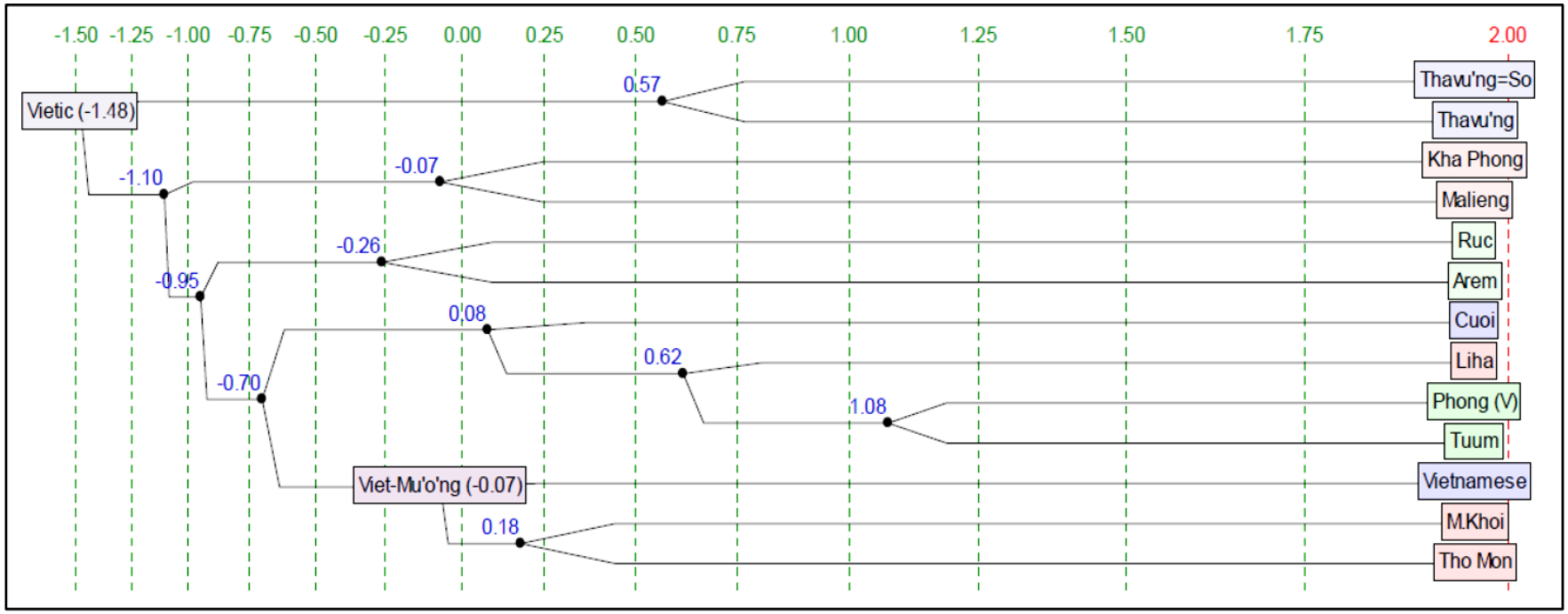


Figure 3-10. Vietic classification by Peiros (2004: 37).

Nguyễn (2009b, 2009a) based himself on the Swadesh list of 100 basic words with minor modifications to compare the Vietic languages Vietnamese, Mường, Nguồn, Thổ (Cuối) and Pọong. Among other findings, Nguyễn suggested that (i) Nguồn, Mường, and Vietnamese are distinct languages, (ii) Thổ should be divided into two languages, Thổ and Cuối, and (iii) Pọong-Đan Lai (as well as Ly Hà) is equally distant from all other languages considered in the study, which is in accordance with the above results from Nguyễn (1993).

Sidwell and Alves (2021b) have recently proposed a new subgrouping of Vietic languages based on computational phylogenetic analysis of a 200-word list and a comparison of phonological changes in codas. The results of their research (Figure 3-11) suggest that Vietic has five subgroups: Việt-Mường, Cuối-Thổ, Pọong-Toum, Chứt-Arem, and Thavung-Maleng. This result differs from Peiros (2004), where Thavung and Maleng group together to form a single clade separated from the rest at the root, reflecting the first West-East division of Vietic. Among the four other subgroups, the division goes further between more innovative subgroups in the North (Việt-Mường, Cuối-Thổ) and more conservative subgroups in the South (Phong (Pọong)-Toum, Chứt-Arem). The South subgroup forms a kind of transition between the West clade and the South subgroup of the East clade. The results also show that Mường dialects closely pattern together, contra Phan's (2012) suggestion of direct branching of Mường variants from proto-Việt-Mường. Of high interest to my study is Sidwell and Alves' observation that tonogenesis (from laryngeal codas) happened independently in different Vietic languages, suggesting that one cannot rely much on tone, register, tonogenesis, and registrogenesis to classify them. Unfortunately, they do not discuss the register properties presented in all these languages or explain why independent innovations are likely. In Chapter 7, I will argue that a register

contrast between high and low registers can be reconstructed at the Proto-Vietic level.

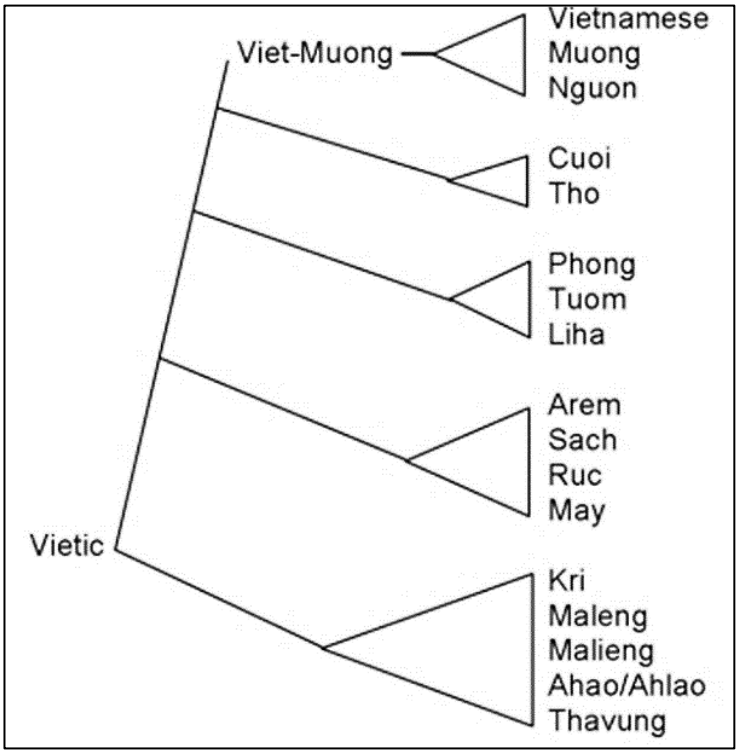


Figure 3-11. Vietic classification by Sidwell & Alves (2021).

In Figure 3-12, I propose a reorganization of the eight Vietic languages described by Ferlus (1998b) into a tree that reflects the lexicostatistic classifications obtained by Peiros (2004) and Sidwell and Alves (2021b). This classification tree will be used to organize the discussion of the tonation systems of Vietic in the next section. Note that the status of Nguồn and its relation to Việt and Mường are left open for reinvestigation and that Cuối and Thổ are represented as a single language, a decision based on Sidwell & Alves's (2021b, p. 179) claim that the distance between Cuối and Thổ is no greater than that between Chứt dialects (Mày, Sách, and Rục).

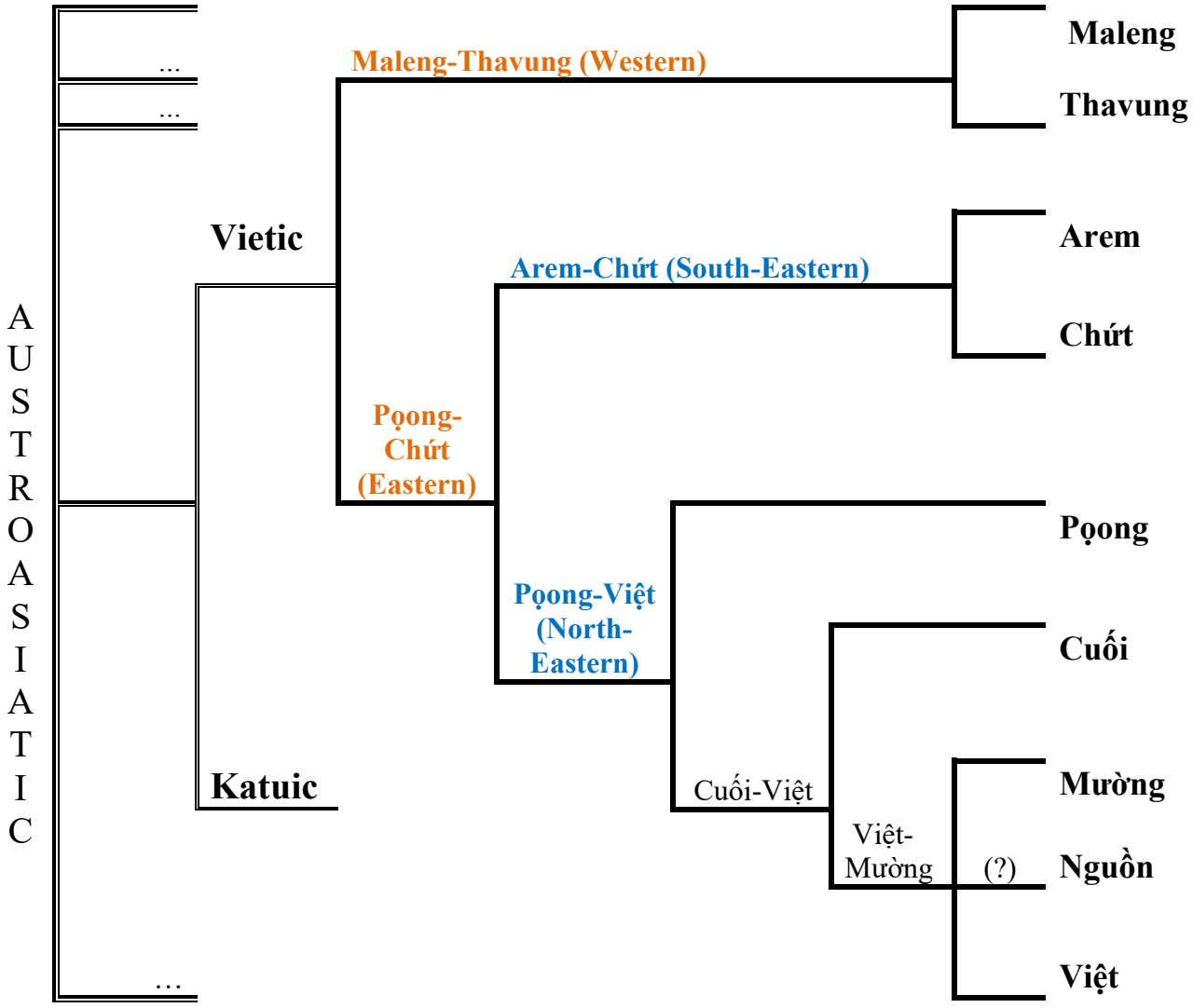


Figure 3-12. Proposed Vietic (Austroasiatic) language tree. The position of Nguồn within the Việt-Mường subgroup has not been firmly determined.

3.2 Descriptions of tonation systems in Vietic

In this section, I present a short description of tonation systems in Vietic languages, which is based mainly on Ferlus (1998b). Ferlus divided and described the tonation systems of Vietic languages based on three primary properties: the number of tones, the presence or absence of breathy phonation, and the presence or absence of tonation-conditioned vowel modifications. (Note that Ferlus used "tone" in its broadest sense, including any tonation

features that developed from the loss of glottal finals and/or onset voicing in Vietic languages). I follow these criteria and describe the tonation systems by language in the order presented in Figure 3-12. Where possible, I complement Ferlus (1998b)'s descriptions with information from later studies on the same languages or new ones, such as Arem (Ferlus, 2013) and Kri (Enfield & Diffloth, 2009). I use the alphanumeric notation (cf. Table 2-3, Chapter 2) to render Ferlus' representations of tone categories.

3.2.1 Maleng

Synchronically, the Maleng dialects in Laos have two tones in sonorant-ending syllables: one non-glottalized rising tone (< *sonorant codas) and one glottalized tone (< *sonorant + ʔ codas). Ferlus (1998b) did not describe the f0 contour of the latter. The glottal final -h is still preserved, and syllables having this coda are unmarked in f0. Ferlus explained that the two-tone system of Maleng is the result of the confusion between high and low registers, by which the breathy phonation in the low register (< *voiced onsets) had disappeared before the f0 perturbation it conditioned could trigger a doubling of the number of tones. There is no description of checked tones (D tones) because Ferlus considered these tones as a sub-system always marked by final stops. The tone system of Maleng is given in Table 3-2.

Table 3-2. Tone system of the Maleng language (Ferlus 1998: 13).

A category	*B category*	*C category*	*D category*
A1/A2 rising	**B1/B2** -ʔ	**C1/C2** -h	**D1/D2** -stop

The original register contrast left traces in the Maleng vowel system: vowels tend

to be more open in the high register, except *a:, which is more closed and backed in the low register. The register-conditioned vowel system of Maleng is given in Table 3-3. Ferlus further noted that in many Maleng dialects, the vowel distinction between the two registers is disappearing under the influence of contact with the Lao (Kra-Dai) language.

Table 3-3. Maleng vowel system by register (Ferlus 1998: 13).

High register			Low register		
ɪː	ɨ̣ː	ʊː	iː	ɨː	uː
e̝ː	ʌː	o̝ː	eː	əː	oː
è̞ː		ɑː	ɛː		ɔː
	aː a			ɒː ɒ	

The Maleng Brô dialect has a different tonation system (Ferlus, 1997a). It has four tones: two non-constrictive tones A1 and A2, and two constrictive tones B1/C1 and B2/C2, the latter two being the result of the confusion of *-h as *-ʔ, which Ferlus explained as being caused by Lao influence, a Tai (< Kra-Dai) language that has no final -h. Breathy phonation is present in the low-register tones A2 and B2/C2. Ferlus' description of the tone system did not provide further information on the f0 contour of the tones but only marked the low-register tones as being lower than their high-register counterparts. The tone system of Maleng Brô is given in Table 3-4.

Maleng Brô vowels are more closed in the low register than in the high register, with the three most open vowels /a: ɔ: ɛ:/ showing prediphthongization (Table 3-5). The tonation system of Maleng Brô, therefore, has all register and tone properties: f0, phonation, and vowel quality.

Table 3-4. Tone system of the Maleng Brô dialect (Ferlus 1997: 57).

	A category	*B category*	*C category*	*D category*
High register	**A1** high	**B1/C1** high, -ʔ		**D1** high + stop
Low register	**A2** low, breathy	**B2/C2** low, breathy, -ʔ		**D2** low, breathy + stop

Table 3-5. Maleng Brô vowel system by register (Ferlus 1998: 24).

High register			Low register		
ɪː	i̤ː	ʊː	ìː	ɨ̀ː	ùː
e̤ː	ʌː	o̤ː	èː	ə̀ː	òː
ɛ̀ː		æː	eɛ̀		oɔ̀
aː	a		ə̀à	ɛ̀	

Kri is a Maleng dialect spoken in Laos that was recently described by Enfield & Diffloth (2009). The language has high and low registers, termed Light and Heavy respectively by the authors. The low register has a breathy phonation type compared to the normal phonation of the high register. Vowels are expectedly more closed in the low than the high register (Figure 3-13). Kri, therefore, has a typical Austroasiatic register distinction.

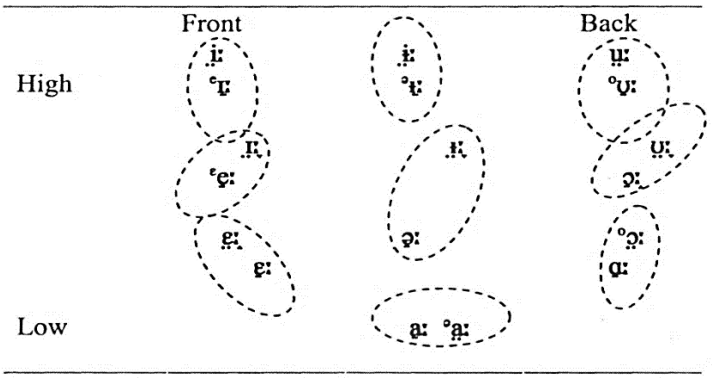


Figure 3-13. Kri long vowels paired by register. In each pair, the higher vowel symbol with the breathy diacritic belongs to the low register (Enfield & Diffloth 2009).

Enfield & Diffloth (2009) also used the term *terminance* to refer to how the rhyme ends: either *voiced* (vowels and plain sonorants), *checked* (final stops, final -ʔ, and glottalized sonorant codas), or *voiceless* (final voiceless fricative -h). We could also opt for a more straightforward solution and regard these terminance distinctions as the presence or absence of the two glottal components -ʔ and -h at the end of the rhyme. Both solutions work, and both indicate that the final glottal properties in Kri have not been lost and are yet to be transphonologized into a f0 contour distinction. In other words, glottal finals are still preserved in Kri, and the language does not have tone *stricto sensu* (pitch height and contour).

3.2.2 Thavung

In Thavung, there are four tones, A1, A2, B1, and B2; the final -h is still preserved, and a register distinction is cued by differences in phonation type and vowel quality (Ferlus, 1998b). The phonetic realization of Thavung tone is given in Table 3-6. Except for the slightly falling contour of the B1 tone, Thavung tones, in Ferlus' description, are all level and are distinguished partly by the relative f0 height between high and low registers.

Table 3-6. Tonation system of the Thavung language (Ferlus 1998: 11). The low register tones are consistently accompanied by a breathy phonation, marked by the IPA symbol for breathiness.

	A category	*B category*	*C category*	*D category*
High register	**A1** 44	**B1** 54ʔ	**C1** 44 + -h	**D1** 44 + stop
Low register	**A2** 1̤1	**B2** 1̤1ʔ	**C2** 1̤1 + -h	**D2** 1̤1 + stop

The magnitude of the f0 and breathiness distinction between the low and high

registers seems to be vowel-height specific. In morphemes with high vowels, the f0 difference between the two registers is predominant, being higher in the high register than the low register, while those with mid and low vowels show more phonation type and vowel differences, being more breathy and having more closed vowels in the low register than the high register (Ferlus, 1998b, p. 12). However, Ferlus's claim that over nearly thirty years (1965-1993), vowels were simplified in the low register through vowel mergers and loss of prediphthongization and that phonation type and f0 differences between the two registers were slowly lost without any compensation (Table 3-7). The four original tones found in open syllables of Thavung are thus now reduced to two tones, A1/A2 and B1/B2, differentiated only by the final constriction of the latter. As Ferlus did not mention tones in syllables ending in -h and stops, it can be assumed that they underwent the same tone merger.

Table 3-7. Evolution of the Thavung vowel system due to loss of breathy phonation and prediphthongization and the vowel merger in the low register (Ferlus 1998: 12).

High register			Low register					
			1965-70			1991-93		
iː	ɨː	uː	ìː	ɨ̀ː	ùː	iː	ɨː	uː
	əː	oː		oɔ̀	oɔ̀		oː	oː
ɛː		ɔː	eɛ̀		oɔ̀	eː		oː
aː	a		əà	ə̆à		ɐː	ɐ	

3.2.3 Arem

Ferlus (2013) described Arem as having two registers: a high register with a clear phonation and a low register with a breathy phonation. This two-register distinction is cross-cut with a final glottalization distinction to yield four distinctive tones: high non-

breathy A1 and B1, and low breathy A2 and B2, with A1 and A2 having no final glottalization and B1 and B2 being finally glottalized. The final -h is still preserved in the language. However, Ferlus provided no phonetic description of the f0 profiles of the four tones and the syllables ending in -h. The tonation system of Arem is summarized in Table 3-8.

Table 3-8. Tonation system of the Arem language (Ferlus 2013: 3).

	A category	*B category*	*C category*	*D category*
High register	**A1** high, clear	**B1** high, clear, -ʔ	**C1** high, clear, -h	**D1** high, clear + stop
Low register	**A2** low, breathy	**B2** low, breathy, -ʔ	**C2** low, breathy, -h	**D2** low, breathy + stop

In Chapter 4, I will show that Arem does not have tone, but rather a register distinction cued by vowel quality and phonation type. F0 does not seem to play a role in the Arem register contrast. The vowel system is split by register, with a tendency to have closer vowels in the low register than in the high register (Table 3-9).

Table 3-9. Arem vowel system in the low (breathy) and high (clear) register (Ferlus 2013: 5).

breathy vowels						*clear vowels*					
ì	*ìː*	*i̤*	*i̤ː*	*ù*	*ùː*	*i*	*(iː)*	*ɨ*	*ɨː*	*u*	*uː*
						ɪ	*ɪː*	*ʉ̟*	*ʉ̟ː*	*ʊ*	*ʊː*
	ìe		*i̤ə*		*ùo*		*ie*		*ɨə*		*uo*
è	*(èː)*	*(ə̀)*	*ə̀ː*	*ò*	*òː*	*(e)*	*eː*	*ə*	*əː*	*o*	*oː*
		ɛ̀	*ɛ̀ː*			*ɛ*	*ɛː*	*(ɐ)*	*ɐː*	*ɔ*	*ɔː*
						æ	*æː*	*ʌ*	*ʌː*	*ɑ*	*ɑː*
								a	*aː*		

3.2.4 Chứt: Mày and Rục

Two dialects of the Chứt language, Rục and Mày, have been described as having the same

tonation system (Nguyễn et al., 1988; Nguyễn, 1993; Solntsev et al., 2001a; Babaev et al., 2021). There has not been a detailed description of Sách, a third dialectal variant of Chứt, but it does not seem to differ very much from Rục and Mày as the three dialects are perfectly mutually intellegible. The Chứt language has four tones: high-level tone A1, low-level tone A2, rising tone B1, and falling tone B2. B1 and B2 have final glottalization, and A2 and B2 have breathy phonation. The final fricative -h is still preserved so that the language does not have the two tones C1 and C2. As there are multiple analyses of the tone system in Chứt, I provide here the most detailed one, reported by Nguyễn (1993) in Table 3-10. Note that Nguyễn provided no description of either tones C1 and C2 or tones D1 and D2 and assumed that they are allophones of A1 and A1, and B1 and B2, respectively.

In addition to a strong breathy phonation in the low register tone A2, previous studies confirmed a register-conditioned vowel split in Rục, according to which vowels are raised or have opening diphthong in the low register (see Table 3-11). A detailed description of the tonation system of Rục will be the focus of Chapter 5.

Table 3-10. Tonation system of the Rục language (summarized from Nguyễn, 1993). The IPA symbol of breathiness is used under tone A2, and the ˀ symbol is used in B1 and B2 tones, indicating final glottalization.

	A category	*B category*	*C category*	*D category*
High register	**A1** 55	**B1** 35ˀ	**C1 (=A1)** -h	**D1 (= B1)** + stop
Low register	**A2** 22̤	**B2** 434ˀ	**C2 (=A2)** -h	**D2 (= B2)** + stop

Table 3-11. Rục vowel system in the high and low register (Ferlus 2013: 14).

High register			Low register		
iː	ɨː	uː	ìː	ɨ̀ː	ùː
eː	əː	oː	èː	ə̀ː	òː
ɛː		ɔː	eɛ̀		oɔ̀
aː	a		əà	ə̆à	

3.2.5 Poọng

The Pọong dialect spoken in the Tương Dương district, Nghệ An province in Vietnam, has four tones in open syllables: A1, A2, B1/C1, and B2/C2. Tone B1 merged with C1, and B2 merged with C2 due to the merge between *-ʔ and *-h before tonogenesis and left final glottalization -ˀ in the low tone B2/C2 only. In checked syllables, vowel length conditions tone variants, which Ferlus considered distinct tones. This tone split in checked syllables is not very common in Vietic nor Austroasiatic languages but is frequently attested in the Kra-Dai phylum (Gedney, 1986; Gedney, 1989). There are neither phonation type nor vowel quality differences between high tones and low tones in Poọng. The Toum dialect spoken in the Viang Thong district, Bolokhamxay province in Laos, has a tone system similar to that of the Poọng dialect. The phonetic realization of these two tone systems is given in Table 3-12. (Ferlus, 1998b).

Table 3-12. Tonation system of the Poọng and Toum dialects (Ferlus 1998: 15).

Poọng	*A category*	*B category*	*C category*	*D category*	
				Long	*Short*
High register	**A1** 24	**B1/C1** 55		**DL1** 11, -stop	**DS1** 44 + stop
Low register	**A2** 32	**B2/C2** 32ˀ		**DL2** 32, -stop	**DS2** 22 + stop
Toum					
High register	**A1** 55	**B1/C1** 213		**DL1** 13, -stop	**DS1** 34 + stop
Low register	**A2** 11	**B2/C2** 32ˀ		**DL2** 53, -stop	**DS2** 32 + stop

3.2.6 Cuối

The Cuối Chăm (or Cuối Tẻ) dialects are spoken in the Tân Kỳ district, Nghệ An province in Vietnam. This dialect has six tones in sonorant-ending syllables. No register-conditioned breathy phonation is found between tones, but final glottalization is present in both B and C tones (Ferlus, 1998b, p. 9). The phonetic realizations of the tone systems in two Cuối Chăm variants are given in Table 3-13. Although the phonetic values of these tone systems need to be verified experimentally, one can note from Table 3-13 that for the dialect Cuối Chăm 2, high-register tones A1 and B1 have a higher f0 than their low-register counterparts A2 and B2.

Ferlus (2001) described Thổ Làng Lỡ, or Cuối Đếp, a Cuối dialect spoken in the Nghĩa Đàn district, Nghệ An province in Vietnam. Compared to Cuối Chăm dialects, Thổ Làng Lỡ merged C1 and C2 tones. Final glottalization is present in this merged tone but not in B tones. Like the Cuối Chăm dialects, f0 is higher in low-register than high-register tones in this dialect. The tone system of Thổ Làng Lỡ is given in Table 3-13, together with those of two Cuối Chăm dialects for a better comparison.

Table 3-13. Tone systems in Cuối dialects (Ferlus 1998: 9, Ferlus 2001: 3).

Cuối Chăm 1	*A category*	*B category*	*C category*	*D category*
High register	**A1** 45	**B1** 324	**C1** 55ʔ	**D1** 34 + stop
Low register	**A2** 43	**B2** 21	**C2** 11ʔ	**D2** 32 + stop
Cuối Chăm 2				
High register	**A1** 11	**B1** 324	**C1** 55ʔ	**D1** 23 + stop
Low register	**A2** 54	**B2** 45ʔ	**C2** 11ʔ	**D2** 32 + stop
Thổ Làng Lỡ (Cuối Đếp)				
High register	**A1** 11	**B1** 24	**C1/C2** 33ʔ	**D1** 24 + stop
Low register	**A2** 55	**B2** 53ʔ		**D2** 53 + stop

There are remnants of register-conditioned vowel changes in Cuối Chăm. The vowel /aː/ is raised to /ɐː/ in syllables with low-register tones A2, B2, C2, and the two back vowels /oː ɔː/ are lowered to /ɔː ɒː/ in syllables with the high-register tones A1, B1, C1 (Ferlus, 1994a). No register-conditioned vowel changes were found in Cuối Đếp (Ferlus, 2001).

Recently, Nguyễn & Nguyễn (2019) provided an experimental description of Cuối Chăm, in which they found a merger between B2 and C2 tones (see Table 3-14). They did not elaborate on this merger but only emphasized that this is a distinction between Cuối Chăm and the dialect of Cuối Đếp (Thổ Làng Lỡ, (Ferlus, 2001), where the merger is between tones C1 and C2. Unfortunately, the authors did not explicitly state if the dialect they investigated is the same as either Ferlus' Cuối Chăm 1 or Cuối Chăm 2.

Table 3-14. The tone system of Cuối Chăm by Nguyễn & Nguyễn (2021).

	A category	*B category*	*C category*	*D category*
High register	**A1** 35	**B1** 24	**C1** 44ˀ	**D1** 35 + stop
Low register	**A2** 41 or 53	**B2/C2** 31ˀ		**D2** 43 + stop

3.2.7 Mường

Tonation systems in Mường dialects are diverse, but they have some common properties: they generally have six tones in sonorant-ending syllables and no register-conditioned phonation type or vowel quality distinctions. Many Mường dialects merge some tones, typically B2 and C2 or C1 and C2 tones, resulting in five-tone systems. Glottalization is often found in B tones in Mường dialects, but as far as I know, there is no report of breathy phonation stemming from either *-h in C tones or the low register. Note, however, that most descriptions of Mường tonation systems are impressionistic (Ferlus, 1998b; Nguyễn, 2005). There is no report of register-conditioned vowel changes in Mường dialects.

The tonation system of Mường Kim Thượng in Phú Thọ province (Nguyễn, 2021) is given in Table 3-15. In this dialect, there is confusion between tones A2 and C2, which merge into a high pitch tone [55].

Table 3-15. Tone system of Mường Kim Thượng in Phú Thọ province (Nguyễn 2021: 59).

	A category	*B category*	*C category*	*D category*
High register	**A1** 53	**B1** 3ʔ3	**C1** 33	**D1** 5 + stop
Low register	**A2** 55	**B2** 35	**C2** 55	**D2** 3 + stop

3.2.8 Vietnamese

Hanoi Vietnamese was presented as an example of a six-tone system in Section 1.2 (Chapter 1). Tones in this dialect are accompanied by phonation type differences that play a role in tone perception, although they differ from dialect to dialect and speaker to speaker (Thompson, 1965; Vũ, 1981, 1982; Edmondson & Lợi, 1997; Pham, 2004; Brunelle, 2009; Kirby, 2011). Whether these breathy and creaky phonation are diachronic remnants of onset devoicing and loss of laryngeal finals (Chapter 2) or semi-automatic consequences of the f0 range (Kuang, 2013b) has not been fully established yet. In comparison, Southern Vietnamese has five tones without phonation differences, following a merger of C1 and C2 (Vũ, 1981, 1982; Brunelle, 2009). Tone-conditioned vowel perturbations have never been reported in either Northern or Southern Vietnamese.

Central Vietnamese tonation systems usually have five tones, like Southern dialects, with a common confusion between C1 and C2. Some dialects merge tones B2 and C2, while others go further in merging tones B2, C1, and C2 resulting in only four surface tones (Ferlus, 1998b; Pham, 2005; Honda, 2008). Average tone curves recorded from speakers in the provinces of Nghệ An and Hà Tĩnh (Honda, 2008, p. 102) are given in Figure 3-14[13]. There is laryngealization in the phonetic realization of the tones B1 and C1/C2, but Honda regards it as a consequence of lowering f0 to the bottom of the f0 range. Likewise, a falsetto phonation at the end of the highest tone A1 is likely conditioned by f0 height.

[13] Obtaining averages from participants speaking different subdialects is not ideal as it is well-known that North-Central Vietnamese dialects have relatively heterogenous tone systems (Nguyễn, 2002; Nguyễn, 2003; Pham, 2005), but few instrumental description of North Central tones are available.

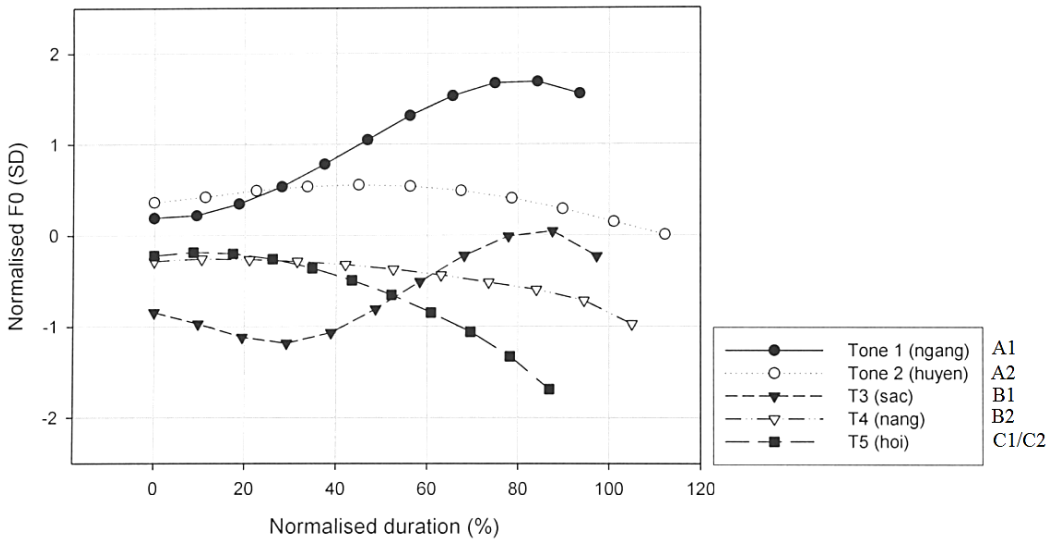


Figure 3-14. Tone system in Nghệ An and Hà Tĩnh (Honda 2008: 102).

3.3 Proto-Vietic reconstruction

Scholars started to reconstruct proto-Việt-Mường in the 1960s (Barker, 1963, 1966; Barker & Barker, 1970; Nguyễn, 2005) by making the most of the first descriptions of Mường (Cadière, 1905; Chéon, 1905, 1907). Then, the first Proto-Vietic reconstructions that used data from smaller Vietic languages other than Mường were published by Ferlus starting in 1975. Ferlus can still, to this day, be credited for most aspects of Proto-Vietic reconstruction (which he calls proto-Việt-Mường), from phonotactics, consonants and vowels to tonogenesis and registrogenesis (Ferlus, 1975; Ferlus, 1997b, 1998b, 2004). Shortly after Ferlus' earliest reconstruction, Sokolovskaja (1978) provided more than 600 Proto-Vietic lexemes and reconstructed the proto-language as non-tonal and non-glottalized (cited in Sidwell & Alves, 2021b, p. 172). More recently, in 1995, Nguyễn Tài Cẩn proposed reconstructed inventories of onsets, codas, and vowels (but not tonation) for Proto-Vietic (Nguyễn, 1995).

A detailed chronological list of reconstruction efforts in proto-Việt-Mường and Proto-Vietic published by Sidwell and Alves (2021b) is reproduced in Table 3-16 for readers' reference. In what follows, I present two reconstructions of Proto-Vietic by Nguyễn (1995) and Ferlus (2014) because these are the latest and include the fullest reconstructions of Proto-Vietic phonology. Other reconstructions in Table 3-16 either stop at the proto-Việt-Mường level or are not within my reach (Sokolovskaja, 1978).

Table 3-16. Comparative reconstructions related to Vietic, reproduced from Sidwell & Alves (2021: 172).

Authors	Years	Level	Notes
Barker	(1966)	VM	Tonal correspondences demonstrated with some 600 VM lexical compari- sons
Barker & Barker	(1970)	VM	Coda and vowel reconstructions supported by 210 VM lexical compari- sons
Ferlus	(1975; 1982)	Vietic	Reconstructs proto-consonants and tones, and their development to modern Vietnamese values
Thompson	(1976)	VM	Reconstructs approximately 700 Proto-VM lexemes based on Vietnamese and three varieties of Muong
Sokolovskaya	(1978)	Vietic	Reconstruction of over 600 Proto-Vietic lexemes supported by data from 27 sources. Proto-Vietic treated as non-tonal, non-glottalized
Ferlus	(1991; 1997a)	Vietic	Reconstructs Proto-Vietic vowels
Ferlus	(1992)	Vietic	Reconstructs Proto-Vietic onset consonants, connecting modern Viet- namese to Proto-Vietic and Chinese loanwords
Nguyen T. C.	(1995)	Vietic	Reconstructs Proto-Vietic inventories of onsets, vowels, and codas (but non-tonal), tracing modern Vietnamese segments to Proto-Vietic and two stages of Chinese loanwords
Ferlus	(1998b, 1999, 2004)	Vietic	Reconstructs Vietic tonal history

Nguyen V. T.	(2005)	VM	Reconstructs VM onsets, vowels, and tones, in addition to one hundred lexemes based on Hanoi Vietnamese, Nghe Tinh (Northern) Vietnamese, and 30 Muong doculects
Shorto	(2006)	AA	Incorporated Viet. and Muong in his reconstruction (including tone cate- gories), tabling consonant correspondences.
Ferlus	(2007)	Vietic	Reconstructs more than 1,200 Proto-Vietic lexemes
Ferlus	(2014)	Vietic	Provides reconstructions of onsets, vowels, and codas in Proto-Vietic (which he calls Proto-Viet-Muong), notes on tonogenesis, and proto-language vowels for his proposed Proto-Pong-Cuoi

3.3.1 Nguyễn Tài Cẩn (1995)'s reconstruction

Nguyễn (1995) proposed the first reconstruction of the phonological system of Proto-Vietic (which he called proto-Việt-Chứt) based on sources available to him at that time, including data from Mường, Arem, Rục, Mày, Sách, Kha Phong, Mã Liềng, Maleng, Thavung, Aheu, Pọong, Hung, and Không Khênh. This reconstruction takes into consideration the phonological word, onsets, vowels, and codas. Nguyễn did not reconstruct any tonation for Proto-Vietic as he followed the consensus in treating tonation systems as a result of tonogenesis and registrogenesis from their segmental origins in glottal codas and onset voicing respectively (Chapter 2).

3.3.1.1 Phonological word

The maximal phonological word in Proto-Vietic has a structure that includes an unstressed presyllable followed by a stressed main syllable. The presyllable is more restricted in its segment inventories than the main syllable. Nguyễn called this structure disyllabic (song

tiết), but the structure he described is, in effect, equivalent to Matisoff's (1973) *sesquisyllable*. The structure of the Proto-Vietic phonological word is as follows:

$$C_pəC_1(C_2)V(V)(C_3)$$

in which $C_pə$ is the presyllable and $C_1C_2V(V)C_3$ is the main syllable. In the presyllable, C_p is the consonantal onset of the presyllable, followed by a phonologically non-distinctive vowel, the schwa /ə/, which could be optionally dropped. C_p can be only one of the following consonants: p, t, c, k, and s. In the main syllable, $C_1(C_2)$ is the onset, a cluster where C_2 can only be -r- or -l-. V(V) is the nucleus of the main syllable that could be long or short. Finally, C_2 is the coda of the main syllable and must be present if the preceding vowel is short. The complete inventories of onsets, vowels, and codas of the main syllable are given below.

3.3.1.2 Onsets

The onset of the main syllable has the fullest inventory of consonants in Proto-Vietic (Table 3-17). The palatal implosive *ʃ is rare. One should also note that Nguyễn reconstructed the labiodental fricative *v for Proto-Vietic but categorized it with glides rather than fricatives.

Table 3-17. Proto-Vietic onsets (Nguyễn 1995: 242).

(*)	p	t	c	k	ʔ
	b	d	ɟ	g	
	ɓ	ɗ	(ʃ)		
	m	n	ɲ	ŋ	
	v	r	j		
		l			
		s	ś		h

3.3.1.3 Codas

Proto-Vietic codas were more restricted than onsets, and stop codas were always unreleased as they are today. The complete coda inventory is given in Table 3-18. Nguyễn's (1995) reconstruction includes few open syllables, and in his system, proto-Austroasiatic *-s and *-ś merged into Proto-Vietic *-s.

Table 3-18. Proto-Vietic codas (Nguyễn 1995: 243).

(*)	-p	-t	-c	-k	-ʔ
	-m	-n	-ɲ	-ŋ	
	-w	-r	-j		
		-l			
		-s			-h

3.3.1.4 Vowels

The complete inventory of Proto-Vietic vowels is given in Table 3-19. Nguyễn (1995) argued that there were no phonologically short vowels /e, ɛ, o, ɔ/ but that these vowels were found allophonically before the glottal fricative *-h, probably *-ʔ, and other codas. Also, note that Nguyễn did not reconstruct any diphthongs for Proto-Vietic. Three diphthongs /iə, ɨə, uə/ in contemporary Vietnameses are, according to Nguyễn, derived from the three most open vowels of Proto-Vietic, /ɛː, ɔː, aː/ when they follow sonorant onsets (1995, p. 141).

Table 3-19. Proto-Vietic vowels (Nguyễn 1995: 244).

(*)	iː	i		ɨ	uː	u
	eː		əː	ə	oː	
	ɛː		aː	a	ɔː	

3.3.2 Ferlus (2014)'s reconstruction

Ferlus' (2014) Proto-Vietic reconstruction is significantly different from Nguyễn (1995), largely because of the addition of new elements. Ferlus added an optional glottal constriction element (ʔ) after sonorant codas in Proto-Vietic syllable structure. This glottal constriction appeared after nasals, laterals, and semivowels, which later derived tones B1 and B2 on these syllables (Section 2.2.2, Chapter 2). The onset, coda, and vowel inventories of Proto-Vietic by Ferlus are given in Table 3-20, Table 3-21, and Table 3-22, respectively.

Table 3-20. Proto-Vietic onsets (Ferlus 2014). Rare segments are parenthesized.

(*)	(pʰ)	(tʰ)	s		(kʰ)	h
	p	t	c	ʧ	k	ʔ
	b	d	ɟ	(ʤ)	g	
	ɓ	ɗ	ʄ			
	m	n	ɲ		ŋ	
	v		j			
		r	l			

Ferlus (2014) added three aspirated onsets and two affricates to the Proto-Vietic onsets that Nguyễn (1995) listed, although he claimed that these segments, except for *ʧ, were rarely encountered.

Table 3-21. Proto-Vietic codas (Ferlus 2014).

(*)	-p	-t	-c	-k	-ʔ[14]
	-m(ʔ)	-n(ʔ)	-ɲ(ʔ)	-ŋ(ʔ)	
		-s		-h	
	-w(ʔ)		-j(ʔ)		
		-r(ʔ)	-l(ʔ)		

[14] This segment is not originally present in the table of proto-Vietic codas but Ferlus rescontructed it as a legitimate proto coda in the lines following this table (Ferlus, 2014).

Ferlus (2014) and Nguyễn (1995) agree on the number and identity of Proto-Vietic codas, except for Ferlus' reconstructed glottal constriction (ˀ) mentioned above.

Table 3-22. Proto-Vietic vowels (Ferlus 2014). Rare segments are parenthesized.

(*)	i:		u:	i	u
	e:	(ə:)	o:	ə	
	ɛ:	ɔ:	a:	a	
	(ia)	(ɨa)	(ua)		

Compared to Nguyễn (1995), Ferlus (2014) added three diphthongs, although he claimed that they were not abundant in the system. He also regarded *ə: as a rare vowel phoneme in the proto-language. Ferlus did not reconstruct the high-mid vowel /ɨ/, assuming that it is a reflex of other proto vowels, such as *ə: and *i:, and this position is echoed in the newest reconstruction of proto-Austroasiatic vocalism (Sidwell & Rau, 2014).

3.3.3 Reconstruction of tonation in Proto-Vietic

No reconstruction work on Proto-Vietic has ever reconstructed tone or register (Sokolovskaja, 1978; Nguyễn, 1995; Ferlus, 2014). All regarded the proto-language as being void of tonation, the only significant suprasegmental phenomenon being the iambic stress of the sesquisyllabic structure. The segmental precursors of tonation, laryngeal codas and onset voicing, were firmly reconstructed at the Proto-Vietic level. However, it is clear from Section 3.2 that synchronically, all Vietic languages have some form of tonation cued by tonal and registral properties: f0 height, f0 contour, vowel quality, and phonation type. In Chapter 7, I will propose reconstructing a register contrast at the Proto-Vietic level but will argue that there is evidence for reconstructing tone from codas as independent innovations

in several branches of Vietic. The evidence upon which this reconstruction is based is presented in Chapters 4-6 and consists of first-hand investigations on the tonation systems of five Vietic varieties, Rục, Arem, and three North-Central Vietnamese dialects.

Chapter 4

Arem – a register language

In this chapter, I investigate the tonation system of Arem, an endangered Vietic language spoken in the Quảng Bình province in Central Vietnam. We will see that Arem has a register contrast mainly cued by vowel quality and phonation type distinctions. Vowel quality has the most important role in distinguishing the two registers, and it has already been phonologized into two vowel subsystems. This register-conditioned vowel distinction is accompanied by a difference between a modal phonation and a breathier phonation in the high and low registers, respectively. The final glottals -ʔ and -h and the glottal constriction in sonorant codas are still preserved in the language, and it has no tone.

I first provide information on the Arem people, their language, and the tonation system of the language in Section **4.1**. Research questions will be laid out at the end of that section. Section **4.2** includes two production studies on the tonation system of Arem. The first study investigates the status of the register contrast in Arem as described by previous researchers. The second study examines the glottal finals ʔ, -h, and the glottalized sonorant codas and their effects on the preceding rhyme. The chapter ends with an interim summary in **4.3**.

4.1 Introduction

4.1.1 The Arem people and their language

4.1.1.1 The Arem people

Before 1959, the Arem people were leading a semi-nomadic life in the mountainous area deep inside the Phong Nha-Kẻ Bàng National Park in the Quảng Bình province in Central Vietnam. Their dwellings were usually located in stone caves or under rocky prominences. In 1959, the local authorities, with the help of military personnel, looked for groups of people living in the forest area near the Vietnam-Laos border and persuaded them to move out and settle in villages. This is when the Arem people gathered and moved to a village in the Thượng Trạch commune (Bố Trạch district, Quảng Bình province) to live with the Katuic-speaking Khùa and Macoong people[15] (Trần, 1995). In 1962, a new commune named Tân Trạch was officially established from a part of Thượng Trạch commune for the Arem people alone, who were now identified as separate people from their Katuic-speaking neighbours. However, some Arem families left the village and returned to their former dwellings in stone caves. The village was also relocated several times due to difficult living conditions and the devastation of the Vietnam war. Recently, all Arem people regrouped in the Tân Trạch commune in a small village next to National Road 20 (Figure 4-1). Over time, people from other ethnic groups also moved to this village because of intermarriage. They are speakers of Sách (Vietic), Bru-Vân Kiều (Katuic), and Khùa and Macoong (also Katuic).

[15] At the same time, the Rục people was found and persuaded to settle in Minh Hóa district of Quảng Bình (Võ, 2012) (more in Chapter 5).

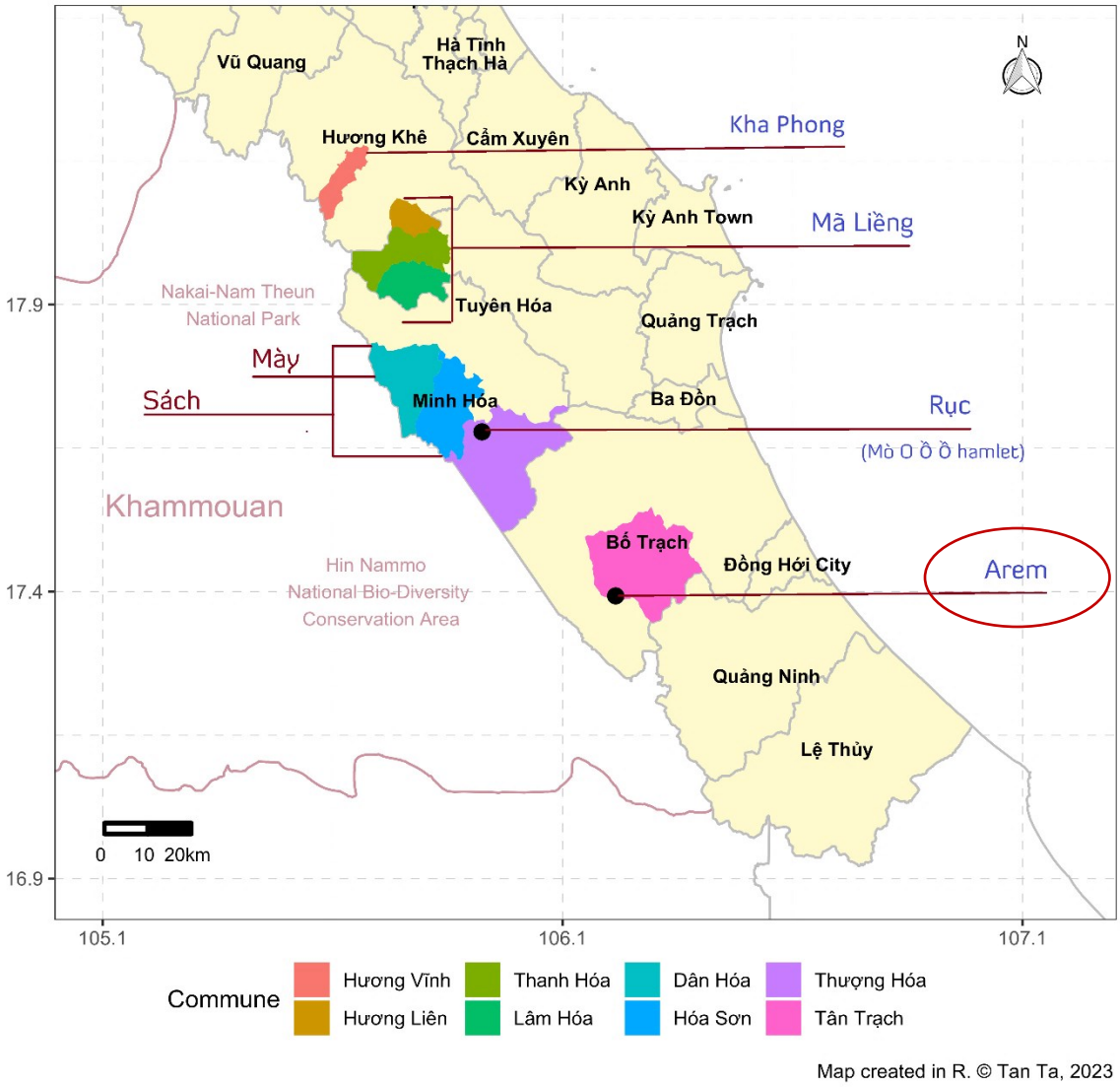


Figure 4-1. Arem-speaking community (circled), along with other Vietic communities, Chứt (Rục, Mày, Sách), Maleng (Mã Liềng, Kha Phong), in the provinces of Quảng Bình and Hà Tĩnh. Two black dots mark the location of the Rục and Arem varieties studied in this dissertation.

Arem population figures vary between sources and should be considered approximations at best. According to Trần Trí Dõi (1995), there were about 100 Arem people in 1960. Vương Hoàng Tuyên reported a population of only 53 (30 men) people in 1963 (1963, p. 67). The former author did a more systematic count of Arem people and reported some 102 people in 2000 (Trần, 2000, p. 110). However, the number of people who

speak Arem natively is dramatically lower than these figures. During his three field trips to the Arem community from 1991 to 1996, Ferlus reported that a little more than twenty people, a quarter of the population, regularly used Arem (Ferlus, 2013, p. 1). During my two field trips in 2019 and 2021, I counted only seven people who could still speak the language. Other people have switched to Khùa and Macoong (Katuic) languages in their daily life. Vietnamese is also used, but only in school and in the administrative sphere.

Since the Arem people moved out of the forest to settle in their village, ethnologists and linguists paid many visits to the community in an effort to identify their ethnological and linguistic affiliation (Nguyễn, 1961b, 1961a; Vương, 1963; Mạc, 1964). Initially, the Arem, along with the Rục and the Mã Liềng, were considered to speak dialectal variants of the Sách language (Vương, 1963; Mạc, 1964)[16]. In 1973, while preparing the official list of ethnic minority groups needed for the population census, a meeting between representatives of the Rục, Mày, Sách, Mã Liềng, and Arem groups was organized, and these people reached an agreement on being collectively referred to as the Chứt (Tạ, 1973). Since then, Chứt is still one of the officially recognized 54 ethnic groups of Vietnam, although, from a linguistic point of view, the Chứt group is comprised of speakers of three different Vietic languages: Chứt (Rục, Mày, and Sách dialects), Mã Liềng (Maleng), and Arem (Ferlus, 1996, 2013).

The Arem should not be confused with the *Harème* in Laos, first mentioned by Rivière (1902a). By comparing Harème lexical items collected by Rivière with Maleng Bro and Arem equivalents, Ferlus confirmed that Harème "should be classified in the Maleng

[16] These authors treated Sách (now classified as a Chứt dialect, along with Rục and Mày, more detail in Chapter 3) as a Mường language, a practise dating back to the beginning of 20th century when Mường language was first documented and described (Cadière, 1905; Chéon, 1905, 1907).

subgroup" (2013, p. 1). It is unfortunate that Haudricourt (1966) mistook Harème as Arem in his notes on the geographic distribution of Austroasiatic languages. Harème is likely the exonym used by the non-Vietic Tai (Kra-Dai) and Katuic people to call minor Vietic-speaking people, just like the name *Kha Tong Luang* (Vietnamese *Xá Lá Vàng*, meaning *dry leave savages*). It is usually assumed that the name Arem is also an exonym used by Katuic Khùa people to refer to this small group of people (Trần, 1995, p. 14).

4.1.1.2 The Arem language

The first Arem lexical list, including 99 words and two simple clauses, was provided in Vương (1963). He presented the Arem data in tables along with data from other Austroasiatic languages (Ơ-đu, Vân Kiều, Khùa, Mày, Pọong, Rục, Mường). Simple lexical comparisons made by Vương revealed that Arem is close to Mày and Rục, and he claimed that they all belong to the Sách (*sic*) language, a dialect variant of Mường (1963, pp. 70-71). Mạc (1964) essentially agreed with Vương in classifying Arem into a group including Mày, Rục, Mã Liềng, and Ma Nghi (a local variety of Sách) and on using the name Sách for all of them. However, after comparing Mày, Rục, Sách, and Arem, Phạm (1973) raised doubt about the position of Arem in this group without providing an analysis to support his claim. Despite this linguistic discrepancy, Arem-speaking people were grouped with Mày, Rục, Sách, and Mã Liềng groups in the officially recognized ethnic group of Chứt in 1973 (Tạ, 1973).

Trần (1983) was the first attempt to classify Chứt dialects based on shared lexicon and phonetic properties. His results showed that Arem was distinct from Sách, Mày, Rục, and Mã Liềng. This separation of Arem from other Chứt dialects was later confirmed in a

more detailed study by the same author (Trần, 1986). In this latter study, the phonetic system of the Mày dialect was chosen as the typical Chứt variety, and phonetic discrepancies between Mày and other dialects were discussed. In every aspect of onset, vowel, coda, and prosody, Arem was shown to be a distinct member of the Chứt group.

The first complete description of the Arem phonemic inventory can be found in Đoàn (1986). In the first years of the 1990s, Kasuga visited the Arem village several times to collect data for his thesis on Arem phonology (Kasuga, 1994). He also prepared a sketch of Arem phonology and compiled a Vietnamese-Arem-English wordlist, none of which has yet been published (Kasuga, 2008a, 2008b), but he kindly shared them with me. The most recent and extensive description of Arem phonology and its role in the study of Vietic languages is found in Ferlus (2013). In what follows, I present a sketch of Arem phonology as a synthesis of these three descriptions (Đoàn, 1986; Kasuga, 2008b; Ferlus, 2013) along with my own understanding of the language after the two field trips taken to the community in the summer of 2019 and the fall of 2021.

4.1.2 Arem phonemic inventory

4.1.2.1 Phonological word

Arem has monosyllabic and sesquisyllabic words, with the latter type accounting for 55-60% of its lexicon, the highest proportion of sesquisyllables in any Vietic language (Ferlus, 2013, p. 2). The two syllabic structures are as follows:

Monosyllable:	$C_1(C_2)V(C_3)$
Sesquisyllable:	$C_pV_p.C_1V(C_3)$

where C stands for consonants, V for vowels (short or long), the subscript $_p$ for segments of the presyllable, and the period (.) for the boundary between the presyllable and the main syllable. When the vowel is short, it must be followed by a coda C_3. Also note that consonantal clusters, $C_1(C_2)$, are found in monosyllables but not in sesquisyllables.

4.1.2.2 The presyllable

The presyllable is unstressed and unmarked for tonation. The presyllable onset C_p includes a restricted set of voiceless stops /p, t, c, k/ and the lateral /l/. The presyllable vowel is one of the three vowels /i, u, a/. These three presyllabic vowels are not phonologically contrastive, meaning there are no minimal pairs formed strictly on the basis of the presyllabic vowel. These vowels can be reduced to a schwa in normal speech. Sometimes, a nasal segment occurs between the presyllable vowel and the consonantal onset of the main syllable, as in the endonym of the Arem people, [cə**m**raw^{ʔ}]. I consider this nasal segment as belonging to the pre-nasalized onset of the main syllable, as in [$^{\mathbf{m}}$pɪː] ‘pepper.’ Therefore, the narrow phonetic transcription of [cəmraw^{ʔ}] is [cə.^{m}raw^{ʔ}]. This solution follows Ferlus (2013), where the author proposed a set of pre-nasalized onsets. The most frequently encountered presyllables in Ferlus’ Arem lexicon are as follows: a- (240), ka- (83), u- (79), ci- (54), pa- (44), ta- (36), i- (30), la- (30), ku- (14) (2013, p. 4).

4.1.2.3 The main syllable

Monosyllabic words and the main syllable of sesquisyllabic words can contain the full range of onsets, vowels, and codas. They are stressed and carry a register distinction realized as a split in the vowel system and phonation type distinction. The following sections describe these inventories.

Onsets

The onset of monosyllables and the main syllable of sesquisyllabic words can be of three types: simple consonants, consonant clusters, and pre-nasalized consonants. The second part of consonant clusters can only be one of the two laterals, /r, l/. As for pre-nasalized segments, their pre-nasal component is usually homorganic with the second part. Arem simple and nasalized onsets and consonant clusters are given in Table 4-1 and Table 4-2, respectively.

Table 4-1. Arem onsets. All series but nasals have pre-nasalized counterparts. Adapted from Ferlus (2013: 4).

	Bilabial	*Labial-dental*	*Alveolar*	*Post-alveolar*	*Palatal*	*Velar*	*Glottal*
Plosive	$^{(m)}$p pʰ $^{(m)}$ɓ		$^{(n)}$t $^{(n)}$tʰ $^{(n)}$ɗ		$^{(ɲ)}$c $^{(ɲ)}$ɟ	$^{(ŋ)}$k kʰ	$^{(ŋ)}$ʔ
Nasal	m		n		ɲ	ŋ	
Fricative		$^{(n)}$v	s (z)	ʃ (ʒ/ʑ)			$^{(ŋ)}$h
Africate				$^{(n)}$tʃ $^{(n)}$dʒ			
Approximant	w				$^{(ɲ)}$j		
Lateral			$^{(n)}$l	$^{(n)}$r			

Table 4-2. Arem cluster onsets. Adapted from Ferlus (2013: 4).

	Bilabial	*Alveolar*	*Palatal*	*Velar*
Cr	pr ɓr	tr	cr	kr
Cl	pl	tl tʰl		kl

Codas

Codas in monosyllables and the main syllable of sesquisyllables include unreleased stops,

the fricative /-h/, nasals, the lateral /-l/, and semivowels /-w, -j/. Coda sonorants have glottalized counterparts encoded by the superscript ˀ. Ferlus (2013) considered the final -ʔ as the glottalized counterpart of vowel-ending rhyme and also transcribed it as ˀ. The synchronic existence of glottalized codas in Arem and Kri (Enfield & Diffloth, 2009) is important to the study of tonation in Vietic and in other branches of the Austroasiatic family as well, as they explain the existence of tone B category in sonorant-ending syllables (Gage, 1985; Diffloth, 1989a; Ferlus, 2004) (see Chapter 2). The coda inventory of Arem is given in Table 4-3.

Table 4-3. Arem codas. Adapted from Ferlus (2013: p.4).

	Bilabial	*Alveolar*	*Palatal*	*Velar*	*Glottal*
Plosive	p	t	c	k	ʔ
Nasal	m(ˀ)	n(ˀ)	ɲ(ˀ)	ŋ(ˀ)	
Fricative					h
Approximant	w(ˀ)		j(ˀ)		
Lateral		l(ˀ)			

Vowels

The Arem vowel system is split into two subsystems conditioned by the register contrast (more in the next section). Vowels in the low register are articulated higher and with a breathier phonation than their high register counterparts, but the most open vowels in the high register have no low register counterparts /æ, æː, ʌ, ʌː, ɑ, ɑː/. The full vowel system in Arem by Ferlus (2013) is given in Table 4-4. According to Ferlus (2013), a Proto-Vietic vowel can have more than two context-conditioned reflexes in each register in Arem, and different Proto-Vietic vowels can yield the same vowel reflexes due to the effect of different coda types. However, a thorough study of historical vowel changes in Arem is

not the focus of this dissertation. Some examples of vowel changes in Arem are given in Table 4-5.

Table 4-4. Arem vowel system according to Ferlus (2013, p.5). Vowels in the first row of the clear vowels set are borrowed from or influenced by Vietnamese and do not contrast with those in the second row.

breathy vowels						*clear vowels*					
ì	*ì:*	*ɨ̀*	*ɨ̀:*	*ù*	*ù:*	*i*	*(i:)*	*ɨ*	*ɨ:*	*u*	*u:*
						ɪ	*ɪ:*	*ʉ*	*ʉ:*	*ʊ*	*ʊ:*
	ìe		*ɨ̀ə*		*ùo*		*ie*		*ɨə*		*uo*
è	*(è:)*	*(ə̀)*	*ə̀:*	*ò*	*ò:*	*(e)*	*e:*	*ə*	*ə:*	*o*	*o:*
		ɛ̀	*ɛ̀:*			*ɛ*	*ɛ:*	*(ɐ)*	*ɐ:*	*ɔ*	*ɔ:*
						æ	*æ:*	*ʌ*	*ʌ:*	*ɑ*	*ɑ:*
								a	*a:*		

Table 4-5. Examples of high-register (red) and low-register (blue) reflexes of Proto-Vietic vowels in Arem. Adapted from Ferlus (2013).

*i:	ì: ɪ:	*ɨ:	ɨ̀: ʉ:	*u:	ù: ùə ʊ: uə
*e:	ìə ɪ: i̇ə	*ə	ì ɨ̀ ɪ ʉ	*o:	ùə uə
*ɛ:	ìə i̇ə	*a:	ìə ɛ̀: a: æ: ɛ:	*ɔ:	ùə ɑ:

4.1.3 The tonation system of Arem: previous studies

In previous studies on Arem phonetics and phonology, the consensus is that Arem has an Austroasiatic-type register contrast resulting from the devoicing of proto-onsets (Đoàn, 1986; Trần, 1986; Nguyễn, 1988; Trần, 1990; Kasuga, 1994, 2008b; Ferlus, 2013). This may be oversimplistic, as there is strong evidence, both from the data found in available descriptions and from my own fieldwork, that the register contrast is not limited to syllables

headed by plain stops, but can even be found after aspirates, implosives, and sonorants, as in 'big bamboo basket' *kʰaŋ* vs. 'back basket' *kʰèŋ,* 'to hike' *mɨ̀ːk dɯ̂h* vs. 'navel' *udʊ̂h*, and 'thigh' *ulaw* vs. 'betel' *ulèw* (the grave accent above vowels mark the low register). An explicit point of divergence between previous researchers is that they do not agree on whether Arem has tones or not. Some authors explicitly claimed or implicitly assumed that Arem has no tone (Đoàn, 1986; Trần, 1986; Nguyễn, 1988; Kasuga, 1994, 2008b), while others argued that Arem has four tones (Trần, 1990; Ferlus, 2013).

According to Đoàn (1986), the contrast between high and low "pronunciation styles" (*kiểu phát âm*) is, in essence, similar to the register contrast one usually encounters in ESEA languages. Compared to the high register, the low register in Arem has the following properties and effects: (i) the larynx is lowered; (ii) the vocal folds vibrate slower but more strongly; (iii) the vowel tends to be lower (*sic*); and (iv) the onset is voiced. The author did not support these claims with empirical evidence.

Ferlus (2013) provided the most recent description of the Arem register. He characterized the high register as having a high (pitch)-clear phonation and the low register as having a low (pitch)-breathy phonation. These pitch (f0) and phonation type differences are realized on vowels, whose quality is also conditioned by register: they tend to be higher (more closed) in the low register. Ferlus' Arem corpus is available online (https://pangloss.cnrs.fr/corpus/Arem?lang=en), but there has not been an acoustic study to confirm the registral properties of Arem.

In Kasuga's (2008a, 2008b) material, vowel quality distinctions between the two registers are not marked. Low register vowels are marked with a grave accent (`), but it is unclear whether this symbol stands for f0 or phonation difference or both.

Trần (1986) claimed that Arem had no tone (1986, p. 17). However, after collecting new data, he reconsidered Arem as having a 2 x 2 tone system (1990) contrasting f0 *height* and *contour*. According to him, a non-level tone is derived from the loss of -ʔ and contrasts with an unmarked level tone in the sonorant-ending syllable. Because the language already has a distinction between high and low registers, these two f0 profiles have higher and lower variants, giving a total of 2 x 2 tones. The final fricative /-h/ is still preserved, and syllables ending in it bear level tones. Trần did not mention checked syllables, but I assume that he considered them as allotones of B1 and B2 tones. The tone system in Arem, according to Trần (1986), is summarized in Table 4-6.

Table 4-6. Arem tonation system as described by Trần (1990).

	A category	*B category*	*C category*	*D category*
High register	A1 high-level	B1 high-rising	C1 = A1 high-level	D1 = B1 high-rising
Low register	A2 low-level	B2 low-falling	C2 = A2 low-level	D2 = B2 low-falling

Nguyễn (1988), on the contrary, considered Arem as having no tone yet. He stated that the pitch contour in syllables ending in stops and post-glottalized sonorants is non-level, compared to the level pitch contour in open and plain sonorant ending syllables. However, he argued that this non-level vs. level pitch contour difference is just a "redundant" property and an automatic phonetic by-product of coarticulation with different types of codas. Nguyễn claimed that this redundant pitch property has not yet been transphonologized into a tonal contrast in Arem.

Ferlus (2013) described Arem as having four tones, an analysis by and large similar to Trần (1986)'s description. Ferlus described tones B1 and B2 as having final glottalization,

a type of weak glottal stop ʔ, that is not accompanied by creaky voice. However, Ferlus was not explicit on the contour of the two glottalized tones. The two low-register tones also have a breathy phonation realized on the vowel. If Ferlus's description of Arem tones is accurate, its tonation system is a hybrid system of tone and register. The Arem tonation system and its correspondences with the Vietnamese tonation system, as suggested by Ferlus (2013), are reproduced in Table 4-7.

Table 4-7. Arem tonation system and Vietnamese correspondences, reproduced from Ferlus (2013). The grave accent on the vowel in the Arem table indicates low pitch and breathy phonation.

Arem	*voiced finals* (# w j l m n ɲ ŋ)		*unvoiced finals* (h) / (p t c k)	
series 1 (hight-clear)	a	aʔ	ah	aC
series 2 (low-breathy)	à	àʔ	àh	àC

Vietnamese	*voiced finals*			*unvoiced finals*
series 1 (*tones a á ả*)	*ngang*	*sắc*	*hỏi*	*sắc*
series 2 (*tones à ạ ã*)	*huyền*	*nặng*	*ngã*	*nặng*

4.1.4 Research questions

Given the lack of consensus on the nature of the Arem tonation system, I conducted two production studies to answer the following questions:

1. How is register phonetically realized in Arem in terms of f0, phonation type, vowel quality, and other durational properties?
   - Is there a systematic f0 difference between the low and high registers?
   - Is there a systematic phonation type difference, measured by acoustic and articulatory indices, between the two registers?

- Are there vowel quality differences between the two registers?
- Is there any VOT and closure duration difference in onsets between the two registers?

2. Is Arem a tone language?
   - What effect does -h have, if any, on the preceding vowel?
   - Do syllables with the historical glottal stop (-ʔ) coda have final glottalization (a weak ˀ) as in Ferlus (2013)'s description?
   - What is the phonetic realization of glottalized sonorants in the coda position? Are their effects on the f0 and phonation type of the preceding rhyme similar or different from those of the historical glottal final -ʔ?

The first data set of the production study was collected in August 2019 and is archived in the online Pangloss archives at https://pangloss.cnrs.fr/corpus/Arem?lang=en. After analyzing it, it was decided that another field trip was needed. After a two-year interruption due to the COVID-19 pandemic, I returned to the Arem community in November 2021 to record more data. The wordlists, the recording, and the method for analyzing the data are presented in detail in the next section.

4.2 The production studies

4.2.1 Method

4.2.1.1 Participants and wordlists

During my first field trip to the Arem community in August 2019, I recorded two female and three male Arem speakers (see Table 4-8). This number of participants is the most I

could work with since there are only seven native speakers left. Except for one female who was 38 years old at the time of recording, the other four were in their 50s – 70s. All speak Vietnamese and Ma Coong, the Bru dialect (Katuic) of their neighbours with whom Arem people often intermarry, and now the primary language spoken in the Arem community. Three people also speak Vân Kiều, another dialectal variant of Bru; two people speak Rục (Chứt) language; and one older male speaks Lao, a Tai language, thanks to his earlier contact with Lao people on the other side of the Laos-Vietnam border.

Table 4-8. Arem speakers in the first data collection in August 2019.

Participant	*Sex*	*YoB*	*Languages spoken*
F01	Female	1981	Vietnamese, Ma Coong, Rục, Vân Kiều
F02	Female	1966	Vietnamese, Ma Coong, Rục, Vân Kiều
M01	Male	1956	Vietnamese, Ma Coong, Vân Kiều, Lao
M02	Male	1944	Vietnamese, Ma Coong
M03	Male	1959	Vietnamese, Ma Coong

I first compiled a wordlist based on the Arem corpus with IPA transcriptions previously recorded by Ferlus, which is available online at https://pangloss.cnrs.fr/corpus/Arem?lang=en and adjusted it in consultation with two Arem speakers (F02 and M01) before recording.

The wordlist originally included 69 lexical items with various coronal and velar onsets; however, for the purposes of this study, only the 40 items with plain stops and liquids will be analyzed, as the 29 words with aspirates and implosives onsets and with two vowels /ɑː, æː/ were deemed insufficiently balanced for register, place, and vowel to allow for a meaningful comparison. The words analyzed here are words made up of the four

consonantal onsets /t, k, r, l/ combined with five pairs of vowels, /ìː, ɪː/ < *i, /ùː, ʊː/ <*u, /èː, ɛː/ < *ɛ, /ɔː, ùə/ < *ɔ, and /aː, ɐ̀ː/ < *a. The grave accent (`) on the first vowel of each pair represents the low register in Ferlus (2013)'s transcription conventions. Words with two low-register vowels /èː, ùə/ were checked and confirmed to be low-register reflexes of proto-vowels /*ɛː, *ɔː/, respectively. Monosyllabic words were preferred; otherwise, I chose target syllables which were the main syllable of sesquisyllabic words. Open syllables were also preferred to nasal and stop-final syllables; the latter two were used only when open syllables were not available. Due to gaps in the system, sometimes I had to choose words with short vowels. As there are not many syllables with the vowel /èː/, I used other onsets than those just mentioned ('tea' /cèː/, 'cat' /mèːw/, 'sesame' /mèː/). The full wordlist is provided in Appendix 4-1.

I analyzed the recorded data in the following months and realized that more data about syllables ending in the final fricative -h and glottalized sonorant codas (nasals, glides, lateral) was needed. Therefore, I made a second field trip to the community in September 2021. In this second field trip, I recorded only four speakers: two females and one male (M01) from the last trip and another male born in 1985. The wordlist used this time included 81 lexical items and is given in Appendix 4-2. As in the previous list, target syllables were monosyllabic words or the main syllable of sesquisyllabic words. They consisted of four different types of codas (glottal fricative -h, glottal stop -ʔ, lateral -l, and glottalized lateral -lˀ) and open syllables combined with high-register vowels /iə, uə, iː, ʉː, ʊː, eː, əː, oː, ɔː, ʌː, aː, ɑː, æː/ and low-register vowels /ìə, ùə, ìː, ɨ̀ː, ùː, ò, ɐ̀/. Onsets were not controlled in order to obtain a sufficient number of target syllables.

One woman (F01) also recorded a 37-word list with a more comprehensive set of

glottalized nasal codas. The target syllables in these words end in nasal and glottalized nasal codas /n, nˀ, ɲ, ɲˀ, ŋ, ŋˀ/ in combination with different vowels in the two registers. This wordlist is given in Appendix 4-3.

As the number of participants is modest, the Arem results will be presented by speaker to allow an intuitive inspection of individual variation. I will not combine the three wordlists as will be done for the more systematic Rục data (Chapter 5) because the three Arem wordlists have different purposes and data structures. The first wordlist is used to investigate the realization of the register contrast. The second wordlist is meant to study the effects of different codas on the f0, phonation type, and duration of preceding rhymes (which have been analyzed as tones by some previous authors). The last wordlist provides experimental evidence on the existence of glottalized sonorant codas, which have become recognized as a central diachronic factor in Vietic tonogenesis (cf. Chapter 2).

4.2.1.2 Recording

During all recording sessions, I read the target words in Vietnamese to the Arem participants and asked them to translate and pronounce them in the following frame sentence:

upæ: ti: maj ___ mɪ: ciŋat
I say sound ___ you hear
'I say the word ___ for you to hear.'

The three wordlists were all recorded four times, each with different randomizations. Recordings were made in the same wooden house in the community on both field trips. Sometimes, recording sessions were interrupted by noise from moving vehicles or domestic animals. In these cases, the affected tokens were discarded right away

and replaced by asking the speakers to repeat them one more time. Recording sessions took 25 – 40 minutes per speaker and were produced with the help of a Macbook running the SpeechRecorder application.

Four types of acoustic information were recorded in the summer of 2019. First of all, a high-quality sound channel was obtained with a Shure Beta53 headset connected directly to a Steinberg UR242 amplifier. A Rothenberg EG2PCX electroglottograph was used in parallel to record three types of signals. The first one is a signal representing the opening-closing activities of the vocal folds (henceforth EGG). The second is a signal representing the vertical movement of the larynx (henceforth LT, larynx tracking), which can be acquired with the EG2PCX electroglottograph because its electrodes are horizontally split into two equal halves, allowing a measure of the difference in electrical resistance between the upper and lower parts of the electrodes that can then be used as an indicator of the vertical position of the larynx (Rothenberg, 1992). The third signal was a low-quality sound channel recorded using a Behringer ECM8000 microphone connected to the EG2PCX device, which was used as a back-up and to ensure the proper alignment of the EGG, LT, and high-quality audio signals.

To record EGG and LT signals, the two dual-channel electrodes of the EG2PCX device were positioned on each side of the subject's thyroid cartilage (*Adam's apple*) and held stable by an adjustable velcro strap. A continuous small electrical current of 1mA runs through the two electrodes, and electrical resistance change varies due to glottal opening. These changes are recorded as EGG signals and considered an indirect indicator of the extent to which the two vocal folds come together or remain separated. The EG2PCX comes with two sizes of electrodes to allow a better fit to the size of each subject's larynx.

I avoided adjusting the position of the electrodes during recording sessions, but if they slid during a recording session because of sweat on the participants' skin, or because of the flabby skin of some speakers, they were adjusted, ideally between repetitions.

The EGG signal was used to help identify the onset of voicing in the audio signal when annotating the data. Only the high-quality audio signals recorded with the Shure Beta53 will be reported. As the LT data show no consistent results, I will not report it. This could be due to the fact that despite the careful setup of the electrodes, they often slightly slid down during recording sessions because of the speakers' flabby skin (four out of five speakers are in their 50s – 70s) and sweat in hot summer days. The EGG data will be analyzed and reported in a separate section about semi-articulatory results.

During the second field trip in winter of 2021, I recorded audio signals only: one channel was recorded with the same Shure Beta53 headset as during the first field trip, and a backup channel was recorded with a Beyer Dynamics M500 TG, both connected to a Macbook running the SpeechRecorder application through a Steinberg UR242 amplifier.

4.2.1.3 Data annotation and processing

Acoustic data (audio signal)

Ninety-six tokens out of 1,850 were excluded due to background noise (wind gusts, domestic animals, vehicles), disfluencies and confusion in target words. The remaining tokens were annotated in Praat TextGrids. In each token, four intervals and two points were marked in the TextGrid file as follows:

- *rv*: the reference vowel /æ:/ in the word /upæ:/ '1SG.'
- *ps*: any sonorant segment that immediately precedes the target syllable.

– *cl*: the closure phase of onset stops or the whole duration of sonorant onsets (nasals, lateral).
– *op*: the open phase, starting from the release of the onset closure to the end of the target syllable (therefore, it includes the aspiration phase of the onset and the whole rhyme (main vowel + coda) of the target syllable).
– *ov*: the onset of voicing, i.e., the time when the vocal folds start vibrating. This could happen before, simultaneous with, or after the release of the onset closure.
– *cd*: the beginning of the coda, if any (stop, nasal, lateral, glide). The total duration of the coda is calculated by subtracting *cd* from the endpoint of the *op* interval.

The above landmarks allow us to calculate the temporal properties of vowels and consonants, such as the closure duration and VOT of onsets, vowel length and rhyme length. This segmentation was done by locating changes in waveforms and spectrograms (formant patterns, burst energy). For the dataset recorded in 2019, the EGG signal was also used to mark voicing initiation and cessation more accurately. An example of audio annotation is given in Figure 4-2.

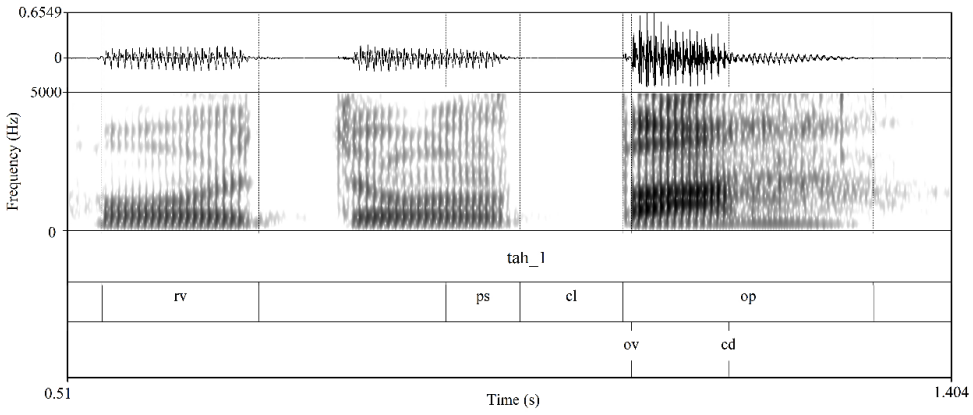


Figure 4-2. Example of audio annotation in a Praat TextGrid for the high-register syllable /tah/.

Acoustic measurements were then obtained using PraatSauce (Kirby, 2018), a Praat-based application measuring spectral properties, which is itself based on VoiceSauce (Shue, Keating, & Vicenik, 2009). f0, F1, F2, H1-H2, H1-A1, H1-A2, H1-A3, and CPP were measured at every 1ms in the target vowel (*op* interval). The amplitude of harmonics (H1, H2, A1, A2, and A3) were formant-corrected (Hawks & Miller, 1995; Iseli & Alwan, 2004) and, therefore, will appear as H1*, H2*, A1*, A2*, and A3*. Because the measurement windows were set at 25ms, measures made at the first and the last 12ms of the *op* interval (largely coincides with the target vowels) will be excluded from the final calculations to avoid factoring in perturbations from adjacent segments.

A two-step process excluded outliers and spurious measurements from the final calculations. Firstly, to exclude sudden f0 and formant tracking errors, f0, F1, and F2 were z-normalized by speaker. Derivatives were then calculated for consecutive sampling points of each of these normalized measures. Measures that were either 0.5 above or -0.5 below the standard deviations of derivatives were excluded. These two thresholds were chosen as a compromise between excluding too many data points and leaving in outliers based on a visual inspection. Spurious values over more extended periods were removed by excluding measurements if they were three standard deviations higher or lower than the means calculated for each property (f0, F1, F2) by speaker*vowel*register. Finally, all H1* and H2* measures based on excluded f0, F1, and F2 were also discarded. In total, the data exclusions are as follows: 9.1% of f0 measures, 5.6% of F1 measures, 5.9% of F2 measures, 9.1% of H1*-H2*, 112.4% of H1*-A1*, 13.1% of H1*-A2*, and 9.1% of H1*-A3* measures.

These amended measurements were then speaker-normalized into z-scores to

facilitate comparison between speakers. However, because z-scaled data are not suitable for intuitive interpretation, the data were reported back to their normal units using the formula: *value = mean of all speakers + z-score * standard deviations for all speakers.* Rhyme duration is also normalized to a 100-point scale in all calculations and graphic representations, except when comparing raw rhyme durations across contexts.

Semi-articulatory data (EGG signals)

EGG was used to obtain an indirect indication of the opening-closing activities of the vocal folds (Childers, Hicks, Moore, & Alsaka, 1986; Childers et al., 1990). From the EGG signal, one can calculate the open quotient (henceforth OQ) of each vocal cycle—the proportion of the opening phase duration divided by the whole cycle duration. A high OQ indicates a longer proportion of glottal opening in each cycle, leading to phonetic effects such as higher breathiness as more air flows through the glottis.

OQ can be calculated by two methods: (i) a method based on derivative EGG signal (therefore dEGG) (Henrich, d'Alessandro, Doval, & Castellengo, 2004; Michaud, 2004), and (ii) a threshold-based method called "Howard's method" (Howard, Lindsey, & Allen, 1990; Howard, 1995). The dEGG method calculates the derivative (the rate of change) of the original EGG signal, and the peaks and troughs in the derived dEGG data are then used as the beginning of the closed and open phases of glottal cycles. The Howard method uses the same algorithm for calculating the beginning of the closed phase but uses a fixed ratio (3/7) of the cycle's amplitude as the threshold for the beginning of the open phase. The estimations from the two methods are comparable, but Howard's method is more robust when there is no clear opening peak in the glottal cycle. These two types of OQ were calculated from the EGG channel obtained from the first field trip with PraatDet, a Praat-

based application written by James Kirby (2020) inspired by *peakdet*, an application developed in the Matlab environment to measure OQ (Michaud, 2007).

PraatDet calculates and displays OQ values based on input settings. It then allows users to manually correct for tracking errors, especially when the EGG signal is not well-defined due to the quality of the recording or because it has an inherent double peaks pattern (especially double closing peaks), leading to uncertainty and variability in marking the opening and closing peaks. For example, Figure 4-3 shows the dEGG and Howard OQs of the rhyme in a token of /kɔːn/ (*upper panel*) calculated based on opening and closing peak points that PraatDet assigns on the dEGG signal (*lower panel*).

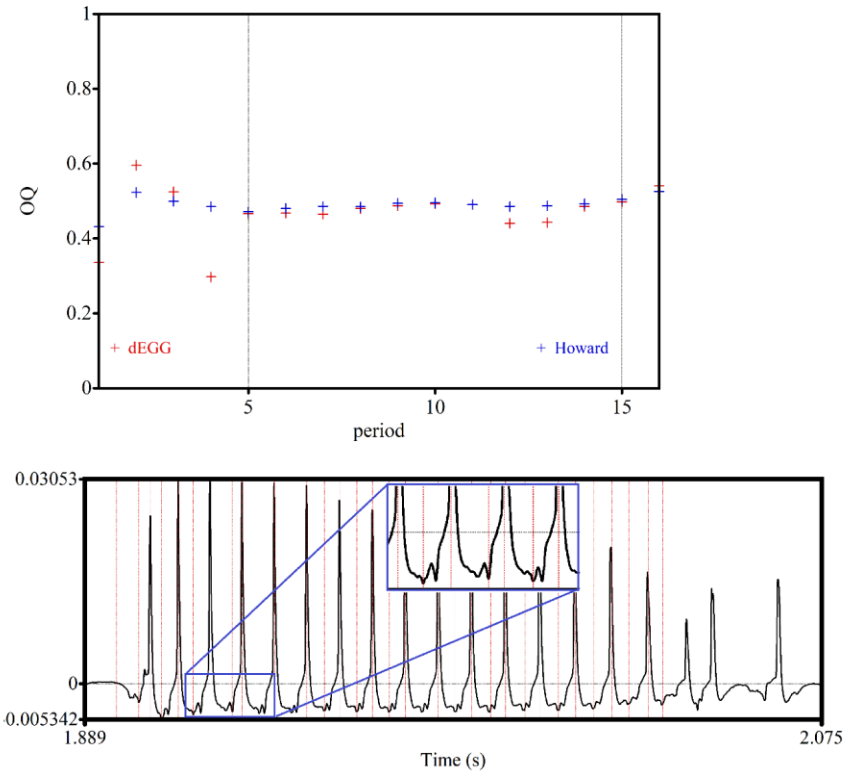


Figure 4-3. Changes in open quotient (OQ) during a token of the syllable /kɔːn/ pronounced by a male speaker calculated by PraatDet with two methods of dEGG and Howard (upper) and the corresponding EGG signal with closing and opening peaks estimated by PraatDet (lower). The two panels were aligned to match OQ scores and detected vocal folds opening phases.

In the above example, PraatDet detects 16 cycles for this interval, with the OQ values being around 0.5 (the vocal folds open roughly half of the time). However, three errors can be readily noticed. Firstly, the first OQ value obtained with both methods precedes observed vocal fold vibrations from the bottom panel. This is because the first two peaks detected by Praatdet (red vertical bars) on the dEGG signal are spurious: the first peak is not present in the EGG signal, where the vocal folds have not started vibrating following the closure release of the onset /k/. Secondly, the third dEGG-based OQ value suddenly drops because its equivalent opening peak is wrongly assigned to the second but not the first dEGG "trough" (the last cycle in the zoomed-in rectangle in the lower panel). Lastly, PraatDet does not detect the last three cycles (no red bars) due to irregularities in cycle duration (lower panel).

All tracking errors, therefore, have to be fixed manually. For instance, the three types of errors in Figure 4-3 were corrected by (i) deleting the two first process points (peaks) on the dEGG window, (ii) relocating the fourth opening peak at the first trough of that cycle, and (iii) adding the three last cycles, yielding the tracking in Figure 4-4. This results in a more regular tracking of OQ for the interval.

Once all tokens in the dataset were manually corrected as needed, OQ results were normalized by speaker as z-scores, and derivatives of each of these consecutive sampling points were calculated. As with the audio measures, an OQ value was considered an outlier and removed if it was 0.5 above or -0.5 below the standard deviation of derivatives; two thresholds were chosen, again, via visual inspection and as a compromise between excluding too much data and leaving in too many outliers. In total, 8.6% of dEGG-based OQ measures and 4.3% of EGG-based Howard threshold OQ measures were excluded.

The cleaned OQ data was then normalized by speaker and reported back to regular scales using the same equation with the audio data.

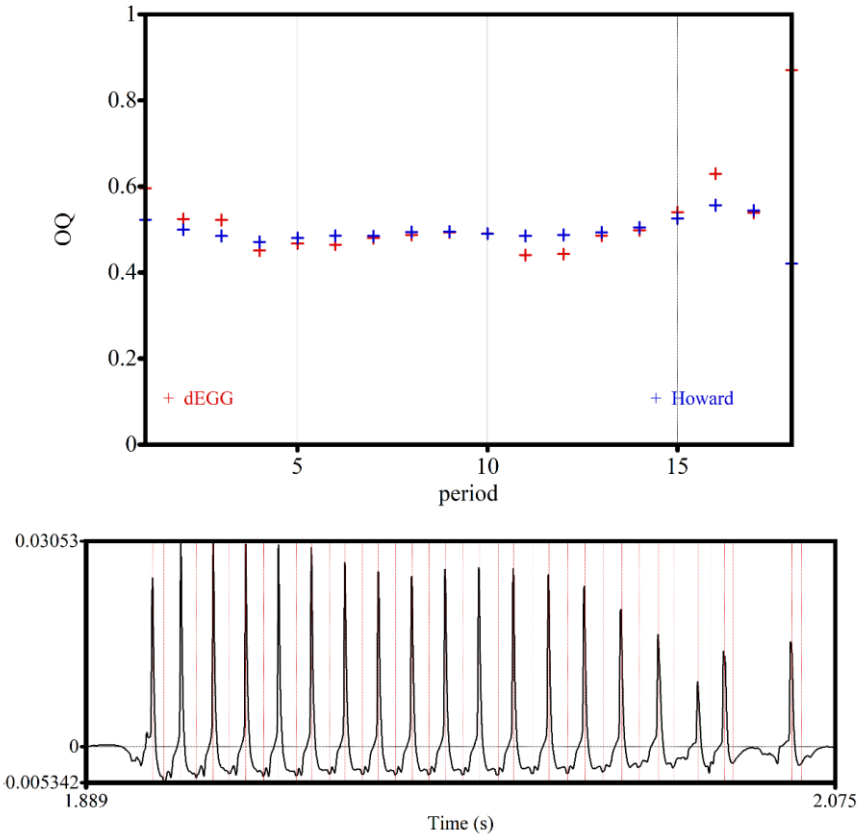


Figure 4-4. Fixing errors in PraatDet OQ trackings (see more in the text).

4.2.1.4 Statistical modelling

Generalized mixed-effect models were fitted to non-time varying data such as VOT, closure duration, and rhyme duration, using the R package *lmer* (Kuznetsova, Brockhoff, & Christensen, 2017). Fixed factors always included the effects of *register, vowel,* and *place of articulation* and their two-way interactions. The three-way interaction between these factors was not included as it corresponds to a single word. *By-subject* and by-*word* random intercepts were included in the models to account for the random effects of *subject* and *word* factors. Random slopes for *speaker* and *word* were not included, as the inclusion of

them usually results in model singularity, a sign of overfitting.

Models were simplified using a top-down approach. The model with the full effect structure was run first. Then, the interaction with the smallest F value was dropped if doing so resulted in a significantly lower Akaike Information Criterion (AIC) when comparing the simplified model with the full one using the *anova* function. This simplification procedure was then repeated iteratively to remove all non-significant interactions and fixed factors that did not significantly improve AIC, with the proviso that fixed factors were never removed if they contributed to a retained interaction. Model simplification stopped when the removal of the interaction or factor with the lowest F resulted in a significant increase in AIC.

For the Arem data, no statistical modelling was attempted with time-varying phonetic properties such as f0, formants, spectral slope measures and CPP. Instead, individual trajectories of these data broken down by speaker will be presented in favour of inspecting individual variations.

4.2.2 Results

In this section, I present the results of the comparison between the two registers of Arem in terms of consonantal properties (§4.2.2.1), vocalic properties, including f0, phonation type, and vowel quality (§4.2.2.2), and a semi-articulatory property, EGG (§4.2.2.3). Vowel duration will not be investigated in this subsection because the first wordlist designed to study the register distinction of Arem has not been well-controlled for the coda. In §4.2.2.4, I use the second wordlist to investigate whether the final glottals -h, -ʔ, and glottalized codas are still present in the language and, if so, how they affect the duration,

f0, and phonation type of preceding rhymes. Data from the third wordlist is also presented in this subsection.

4.2.2.1 Consonantal properties

The VOT distribution of two onset stops /k, t/ in the high and low registers, subset by individual speakers, is given in Figure 4-5. Table 4-9 provides a descriptive summary of VOTs for these two onsets in the two registers.

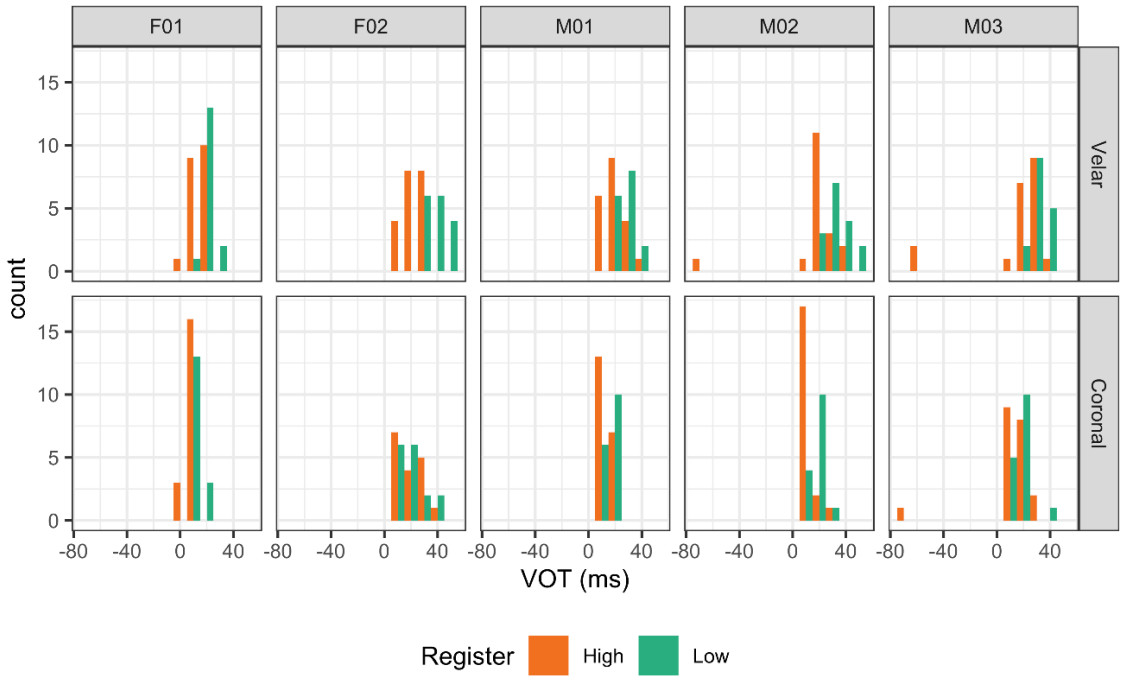


Figure 4-5. VOT distribution of onset stops /k, t/ of Arem in the high register (< *voiced stops) and low register (< *voiceless stops), subgrouped by *speaker*. The data is divided into 10 ms bins; high register bars (orange) are located immediately to the left of the tick corresponding to their lower bounds, while low register bars (green) are immediate to their right.

Table 4-9. Number of tokens (n), mean (in ms), and standard deviation (SD) of VOT of onset stops, by *register* and *place of articulation*.

	High		***Low***	
	Velar	*Coronal*	*Velar*	*Coronal*
n	98	96	80	79
Mean	**18.63**	**12.51**	**30.27**	**16.75**
SD	16.29	11.24	9.12	6.44

In all categories, VOT is always positive, except four tokens in the high registers having negative VOTs, all due to carry-over voicing from a preceding sonorous segment in fast-connected speech. The velar onset /k/ has a longer VOT than the coronal onset /t/ in both registers, which is unsurprising given a cross-linguistic tendency for posterior stops to have a longer VOT (Lisker & Abramson, 1967; Nearey & Rochet, 1994). Of most relevance here is the fact that low register conditions a longer VOT than the high register in both onsets /k, t/, the differences being around 11 and 4ms, respectively (Table 4-9).

In order to see if the register-conditioned VOT differences mentioned above are significant, a mixed model was fitted to the data after excluding the four tokens with a negative VOT. The optimal model has the fullest factor structure and includes *register, vowel, place of articulation*, and their two-way interactions, and a random intercept for *speaker*. The results of the model are given in Table 4-10, and they confirm that both register and place significantly affect VOT: *RegisterLow*: $\beta = 8.13$ ms, $t = 4.95$, $p < .001$, and *PlaceCoronal*: $\beta = -9.81$ ms, $t = -5.98$, $p < .001$. However, the interaction between the low register and the coronal place is also significant and suggests that the VOT difference between registers is negligible on coronals, but not on velars. Besides, the vowel /iː/ and

its interaction with place *coronal* exhibit some VOT effects.

Table 4-10. The results of the optimal mixed-effects regression model fitted to the VOT data. Model: *VOT ~ Register*Place + Register*Vowel + Place*Vowel + (1|Speaker).*

	Estimate	*Std. Error*	*df*	*t value*	*Pr(>|t|)*
(Intercept)	22.85	2.35	8.44	9.73	0.00***
RegisterLow	**8.13**	**1.64**	**330.03**	**4.95**	**0.00*** **
PlaceCoronal	**-9.81**	**1.64**	**330.03**	**-5.98**	**0.00*** **
Vowelɛ	-1.89	1.98	330.03	-0.96	0.34
Voweli	**-6.40**	**1.82**	**330.04**	**-3.52**	**0.00*** **
Vowelɔ	-0.53	1.82	330.03	-0.29	0.77
Vowelu	0.95	1.83	330.02	0.52	0.60
RegisterLow:PlaceCoronal	**-5.54**	**1.47**	**330.03**	**-3.77**	**0.00*** **
RegisterLow:Voweli	3.51	2.06	330.02	1.70	0.09
RegisterLow:Vowelɔ	1.64	2.06	330.01	0.80	0.42
RegisterLow:Vowelu	-2.03	2.10	330.03	-0.97	0.33
PlaceCoronal:Vowelɛ	2.99	2.61	330.01	1.14	0.25
PlaceCoronal:Voweli	**8.11**	**2.06**	**330.02**	**3.93**	**0.00*** **
PlaceCoronal:Vowelɔ	-2.01	2.06	330.01	-0.98	0.33
PlaceCoronal:Vowelu	1.49	2.09	330.01	0.71	0.48

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

The closure duration of two onset stops /k, t/, subgrouped by *register* and *speaker,* is plotted in Figure 4-6. A visual inspection shows that the closure duration of the velar stop /k/ in the high register is shorter than in the low register. This pattern is not present in the coronal stop /t/. However, /t/ has an overall longer closure duration compared to that of /k/.

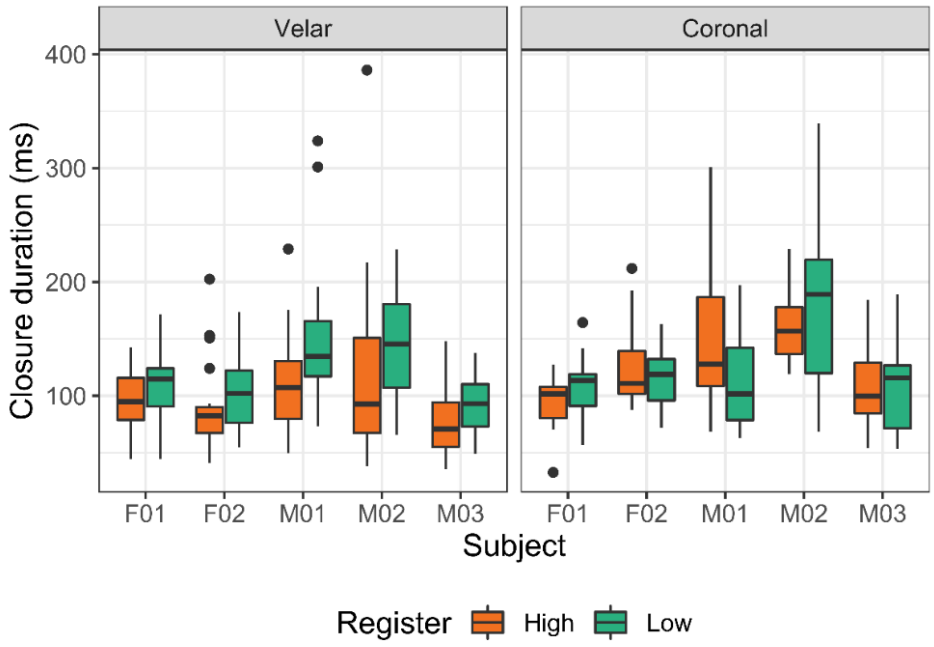


Figure 4-6. Closure duration of plain stops /k, t/ by *register* and *speaker*.

The optimal mixed model fitted to the closure duration data has the same factor structure as that of the model fitted to the VOT data, and its results are given in Table 4-11. The results confirm that the referent onset /k/ has a significantly longer closure duration in the low than in the high register (*RegisterLow*: β = 26.4 ms, t = 2.59, p < .01). The coronal onset /t/ is significantly longer in closure duration than its velar counterpart (*PlaceCoronal*: β = 26.87 ms, t = 2.63, p < .01); however, the effect is cancelled in the low register (*RegisterLow:PlaceCoronal*: β = -28.46 ms, t = -3.12, p < .001). Some vowels and their interactions with two other factors, *register* and *place*, also show significant effects.

Table 4-11. The results of the optimal mixed-effects regression model fitted to the closure duration data. Model: *closure_duration ~ Register*Place + Register*Vowel + Place*Vowel + (1|Speaker).*

	Estimate	*Std. Error*	*df*	*t value*	*Pr(>|t|)*
(Intercept)	96.47	12.76	10.95	7.56	0.00***
RegisterLow	**26.40**	**10.21**	**335.02**	**2.59**	**0.01***
PlaceCoronal	**26.87**	**10.21**	**335.02**	**2.63**	**0.01****

Vowelɛ	**30.69**	**12.29**	**335.01**	**2.50**	**0.01***
Voweli	**-41.62**	**11.19**	**335.01**	**-3.72**	**0.00*****
Vowelɔ	-17.19	11.18	335.01	-1.54	0.12
Vowelu	**38.55**	**11.23**	**335.02**	**3.43**	**0.00*****
RegisterLow:PlaceCoronal	**-28.46**	**9.14**	**335.02**	**-3.12**	**0.00****
RegisterLow:Voweli	9.70	12.86	335.01	0.75	0.45
RegisterLow:Vowelɔ	**32.43**	**12.82**	**335.00**	**2.53**	**0.01***
RegisterLow:Vowelu	**-30.81**	**13.02**	**335.04**	**-2.37**	**0.02***
PlaceCoronal:Vowelɛ	-12.26	16.35	335.01	-0.75	0.45
PlaceCoronal:Voweli	**45.36**	**12.86**	**335.01**	**3.53**	**0.00*****
PlaceCoronal:Vowelɔ	18.14	12.82	335.00	1.41	0.16
PlaceCoronal:Vowelu	**-44.17**	**13.01**	**335.02**	**-3.39**	**0.00*****

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

In short, the low register conditions a longer VOT than the high register, although the difference partially depends on the place of articulation. The low register also induces a longer closure duration than the high register in velars, which suggests that low register stops have become quite distinct from voiced stops, which typically have short closures.

4.2.2.2 Vocalic properties

As the phonetic properties of vowels following onset stops /k, t/ and liquids /r, l/ show no marked differences, I combine and report them together in the following sections.

Fundamental frequency – f0

Figure 4-7 represents the mean f0 on the vowel in the two registers, broken down by *speaker*. Generally, f0 has a tendency to taper off toward the end of the vowel in all speakers. There is no f0 difference between the low and high registers, as the two bold lines overlap for almost the whole vowel interval in speakers F01, M01, and M02 and only show minor distinctions in speakers F02 and M03.

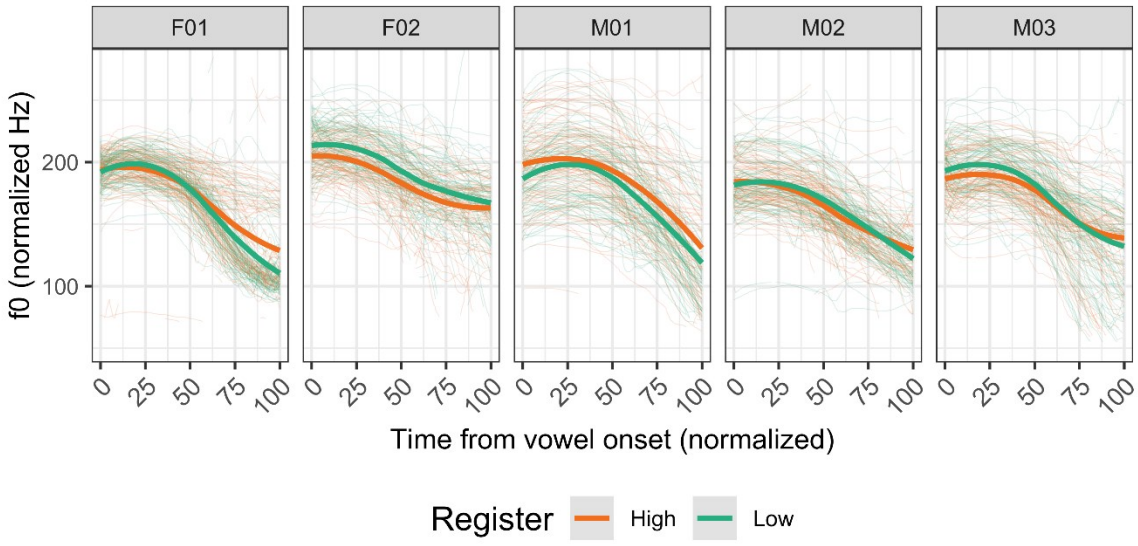


Figure 4-7. Mean f0 on the vowel in the low and high registers (bold lines), by *speaker*. The thin lines represent individual f0 trajectories.

Phonation types

The mean corrected H1*-H2* on the vowel in the two registers is given in Figure 4-8, also broken down by *speaker*. A higher H1*-H2* indicates more energy in the first harmonic frequency H1 than the second harmonic frequency H2, which suggests a breathier phonation type. A lower H1*-H2* is, on the other hand, interpreted as an indication of a tenser or creakier phonation. One can see from Figure 4-8 that all five speakers show a higher H1*-H2* value in the low than the high register, indicating that the low register has a breathier phonation. The maximum difference is about 5dB and steadily lasts throughout the normalized vowel duration (speakers F02 and M03) or shows a gradual convergence in the last part of the vowel (speakers F01, M01, and M02). Other spectral measurements (H1*-A1*, H1*-A2*, H2*-H4*, …) largely show the same difference between the two registers as concerns their H1*-H2* results, and, therefore, I will not report them here.

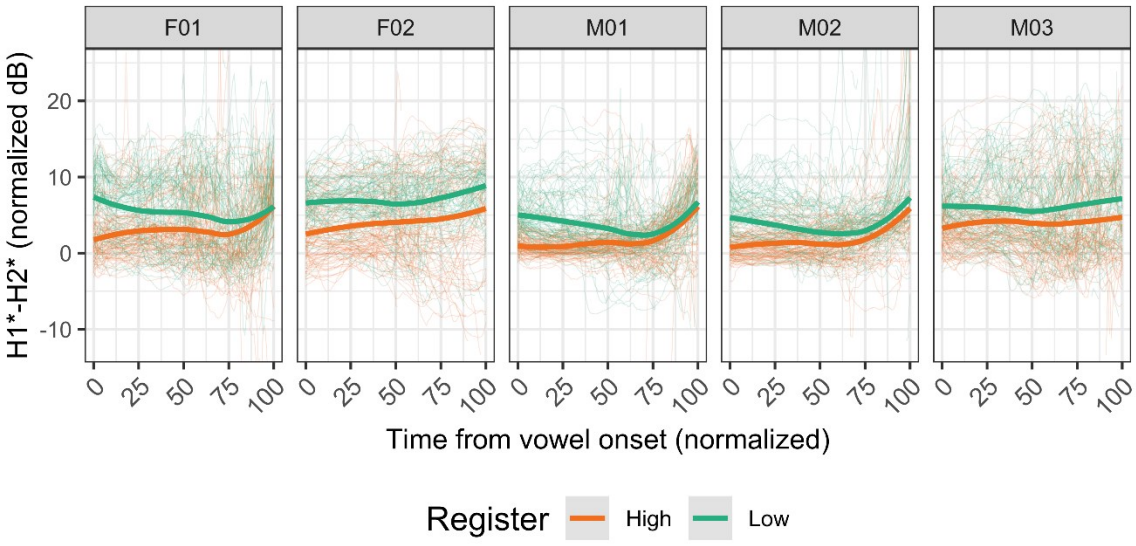


Figure 4-8. Mean H1*-H2* on the vowel in the low and high registers (bold lines), by *speaker*. The thin lines represent individual H1*-H2* trajectories.

The CPP (cepstral peak prominence) of the two registers, a measure of regularity of the vocal fold vibrations and another indicator for phonation type differences, are given in Figure 4-9. A lower CPP value indicates a non-modal (breathy or creaky) phonation. Regardless of the register, the general CPP pattern shown in Figure 4-9 is a rising-falling contour with its peak at around the one-quarter mark of the vowel duration for all speakers. Four speakers (excepting F01) have a higher CPP in the high than the low register, suggesting that compared to the high register, the low register is less modal. In accordance with the H1*-H2* result, this suggests that the low register has a breathier phonation.

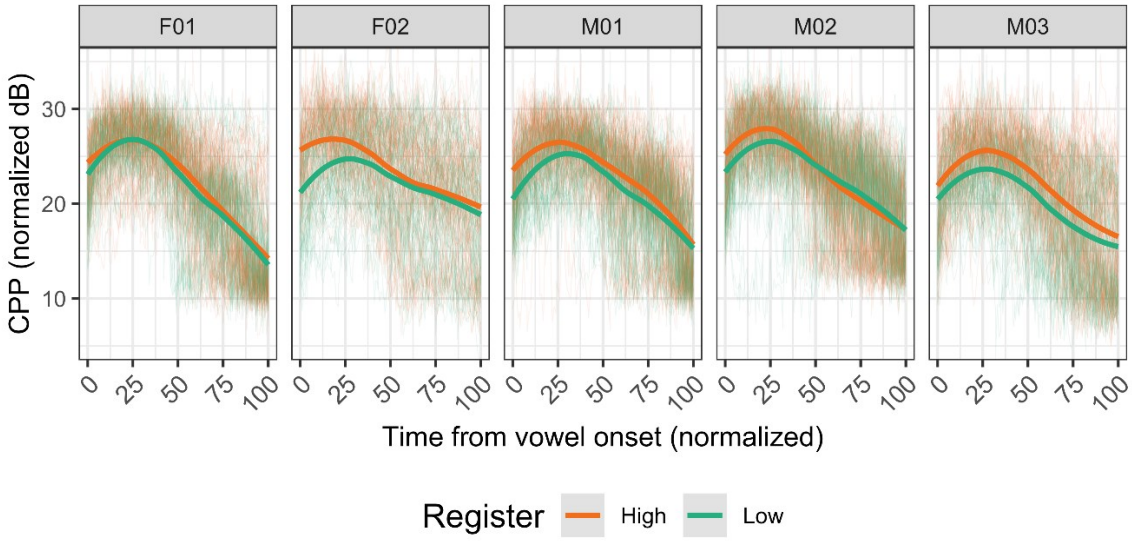


Figure 4-9. Mean CPP on the vowel in the low and high registers (bold lines) by *speaker*. The thin lines represent individual CPP trajectories.

Vowel quality

The first formant (F1) and the second formant (F2) of vowels in five pairs, /ìː, ɪː/, /ùː, ʊː/, /èː, ɛː/, /ɔː, ùə/, and /aː, ɐ̀ː/ in the two registers are illustrated in Figure 4-10 and Figure 4-11, respectively. For the sake of convenience, I use a single vowel symbol reflecting the diachronic source of each of these pairs, marked by a preceding asterisk (*).

In Figure 4-10, one can observe a general tendency for F1 to be higher in the high than the low register in all five vowels and five speakers. The difference is not limited to the vowel onset but lasts almost throughout the vowel duration, indicating vowel raising (i.e. more closed vowels) in the low register. The F1 difference is also larger in three open vowels *ɛː, *ɔː, *aː than in the two close vowels *iː, *uː. In the vowel *aː, F1 rises for the first fourth of the vowel duration in both registers, which is followed by a falling F1 contour.

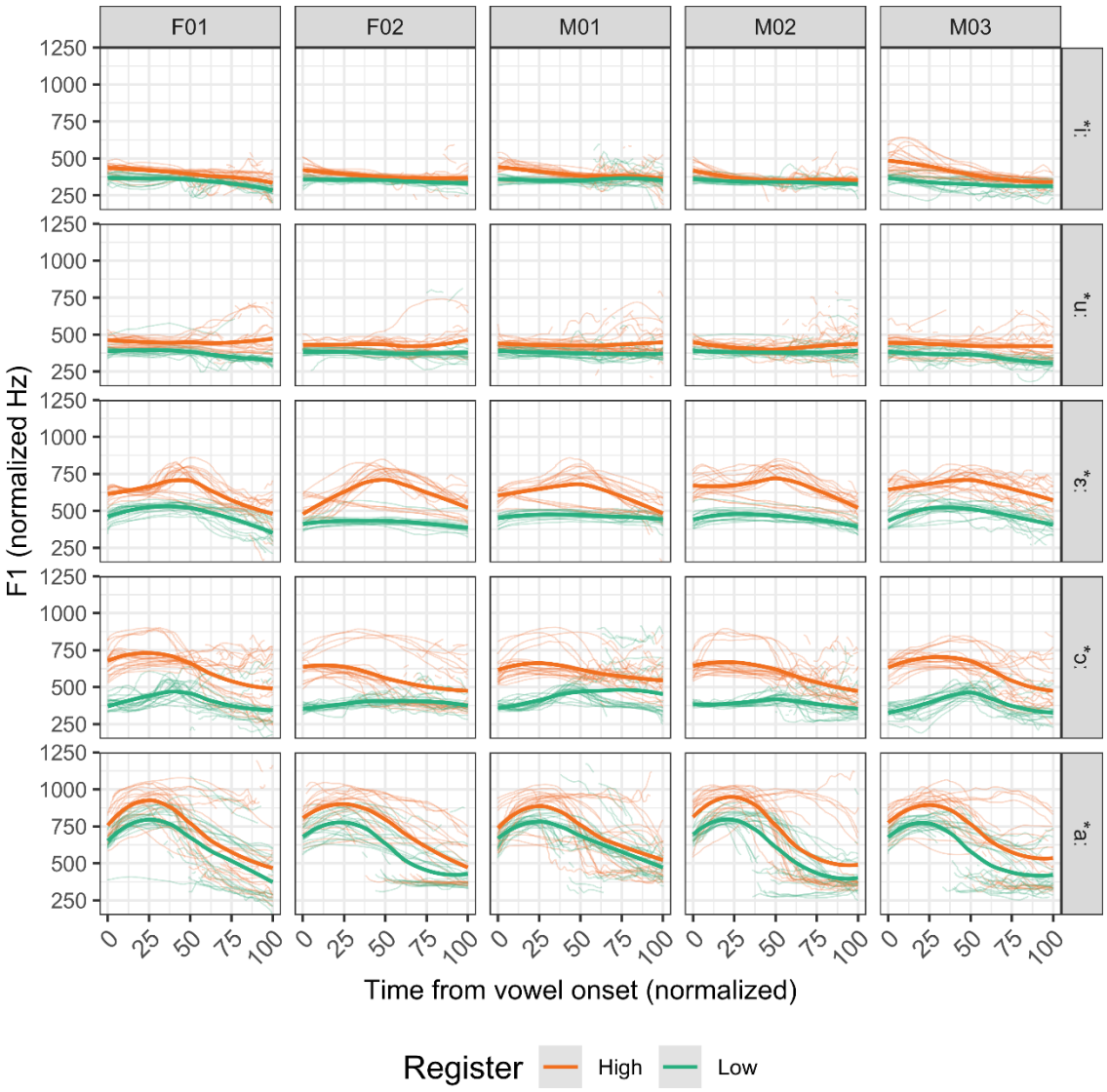


Figure 4-10. Mean F1 on the vowel in the low and high registers (bold lines), by *speaker*. The thin lines represent individual F1 trajectories.

Similar to F1, the disparity between F2 values in the high and the low registers is smaller in the two close vowels, *iː and *uː, than in the open and mid-open vowels, *ɛː, *ɔː, and *aː (Figure 4-11). The latter three vowels have different F2 patterns compared to each other, and in both registers. The F2 of *ɛː shows a general falling contour toward its offset in all five speakers after a slight rise at onset, gradually becoming lower in the high than the low register. The F2 of *ɔː, on the contrary, exhibits a mild rising contour at its

onset, followed by a steeper rise toward its offset, especially in the low register. This reflects the fact that *ɔː is realized as the diphthong /ùə/ in the low register. Finally, F2 in the vowel *aː is higher in the high than the low register, and the difference is maintained throughout vowel duration, indicating that the vowel is further back in the low register.

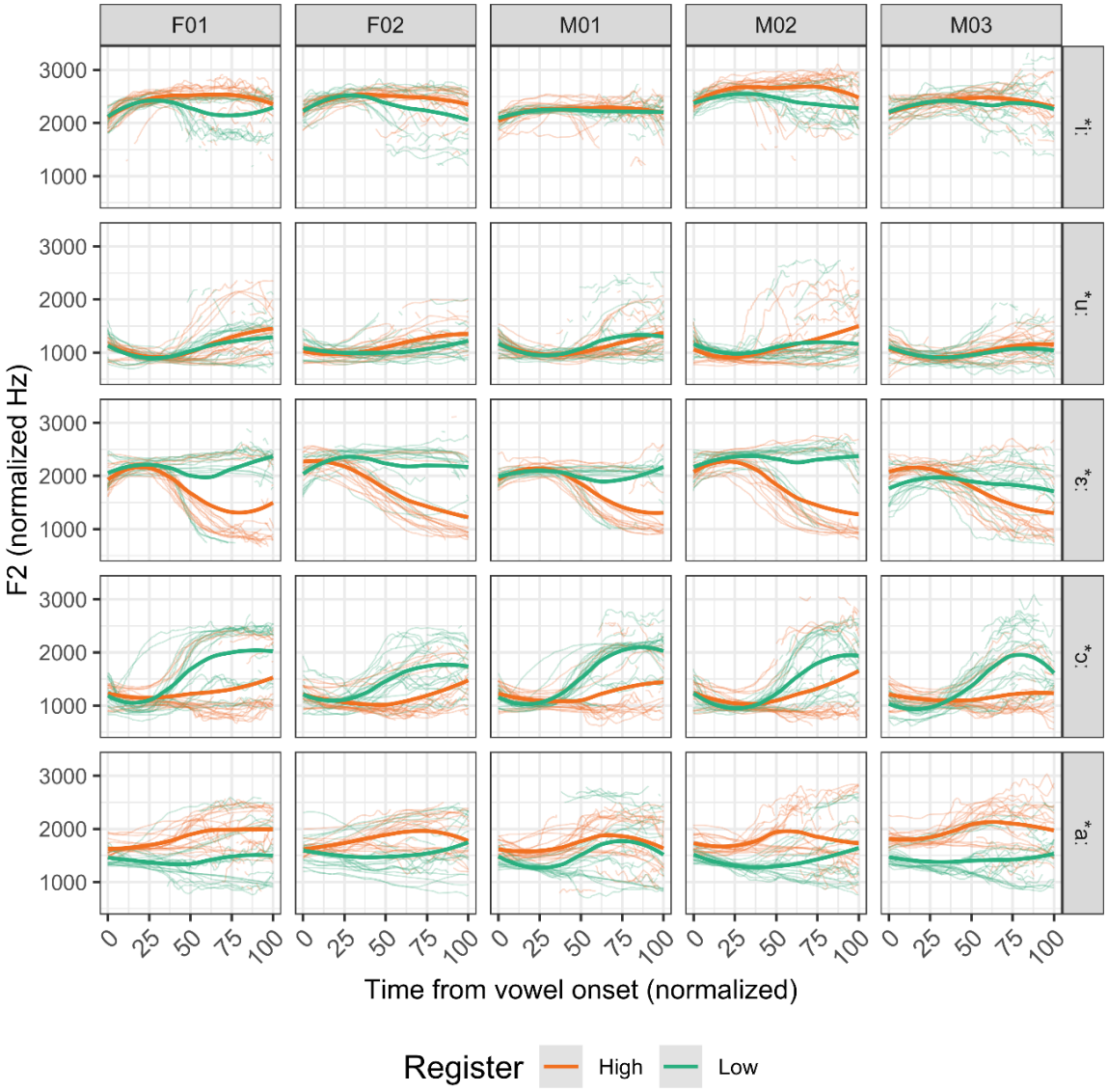


Figure 4-11. Mean F2 on the vowel in the low and high registers (bold lines) by *speaker*. The thin lines represent individual F2 trajectories.

Figure 4-12 illustrates the trajectories of the five vowel pairs from their onsets to their midpoints (upper panel), and their position in the vowel space at the midpoint (lower

panel), all broken down by *register* and *speaker*. The patterns observed are largely the same across speakers. Compared to the high register, the vowels in the low register are higher (more closed articulatorily), and this pattern is more easily detectable for open and open-mid vowels *ɛː, *ɔː, *aː than for close vowels *iː, *uː. In the low register, front vowels often move backward, but back vowels hardly show any fronting, which goes against the claim that vowels are centralized in the low register in the whole vowel system (Henderson, 1952; Shorto, 1962; Shorto, 1967).

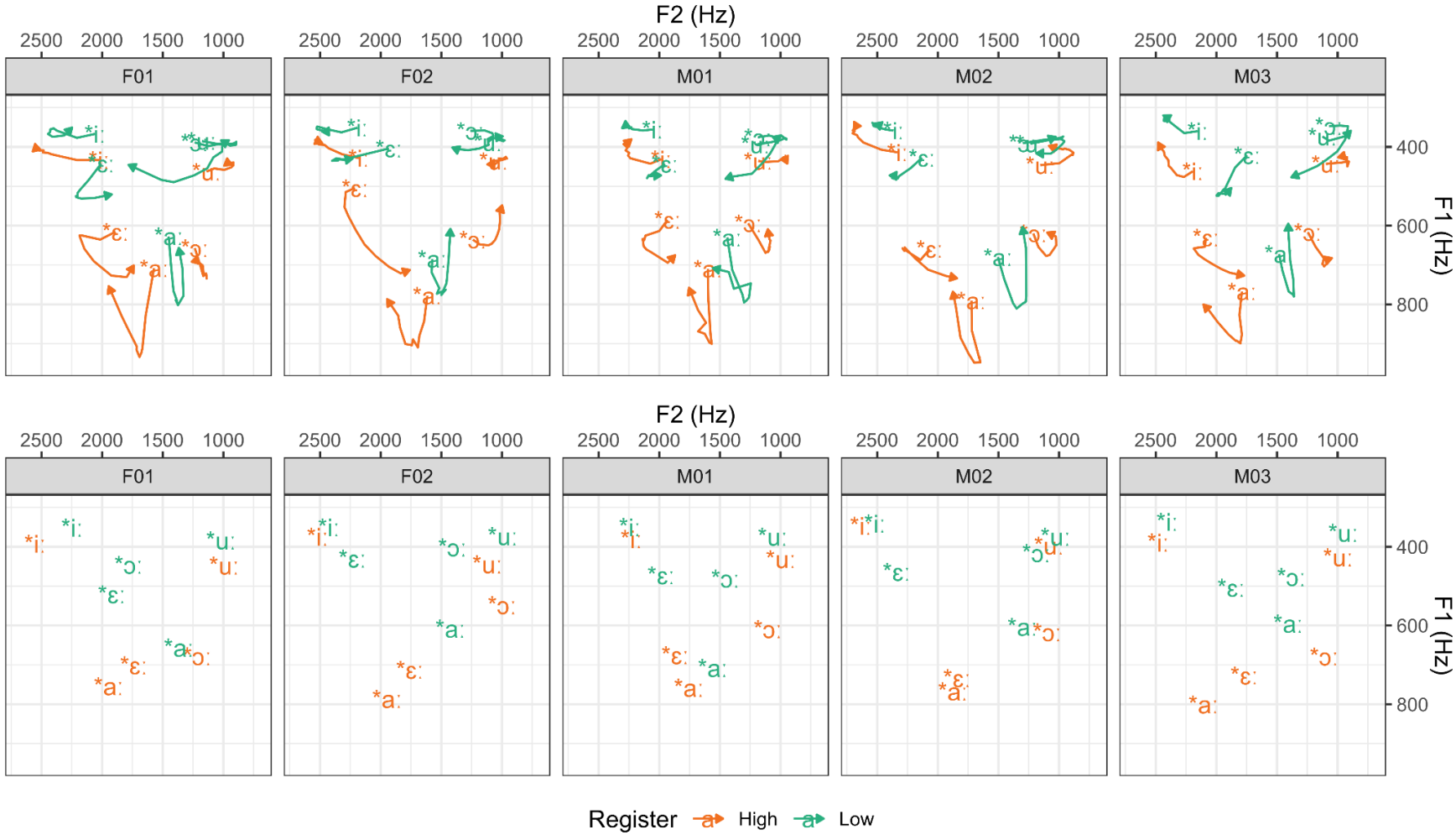


Figure 4-12. Upper panel: F1xF2 trajectories of vowels from their onsets (symbols) to midpoints (arrows) in the two registers, by *speaker*. Lower panel: The position of the vowels at their midpoints, by *speaker*. For clarity, the same IPA symbol is used for the two modern reflexes of each Proto-Vietic vowel (surface values are given at the beginning of the subsection).

4.2.2.3 Semi-articulatory property: EGG

The open quotient (OQ) of the vowel in the two registers is presented in Figure 4-13. The upper and lower panels represent OQ as measured by the dEGG (derivative EGG) method and the Howard method, respectively. A higher OQ indicates that the vocal folds are kept apart for a longer proportion of the glottal cycle and vice versa.

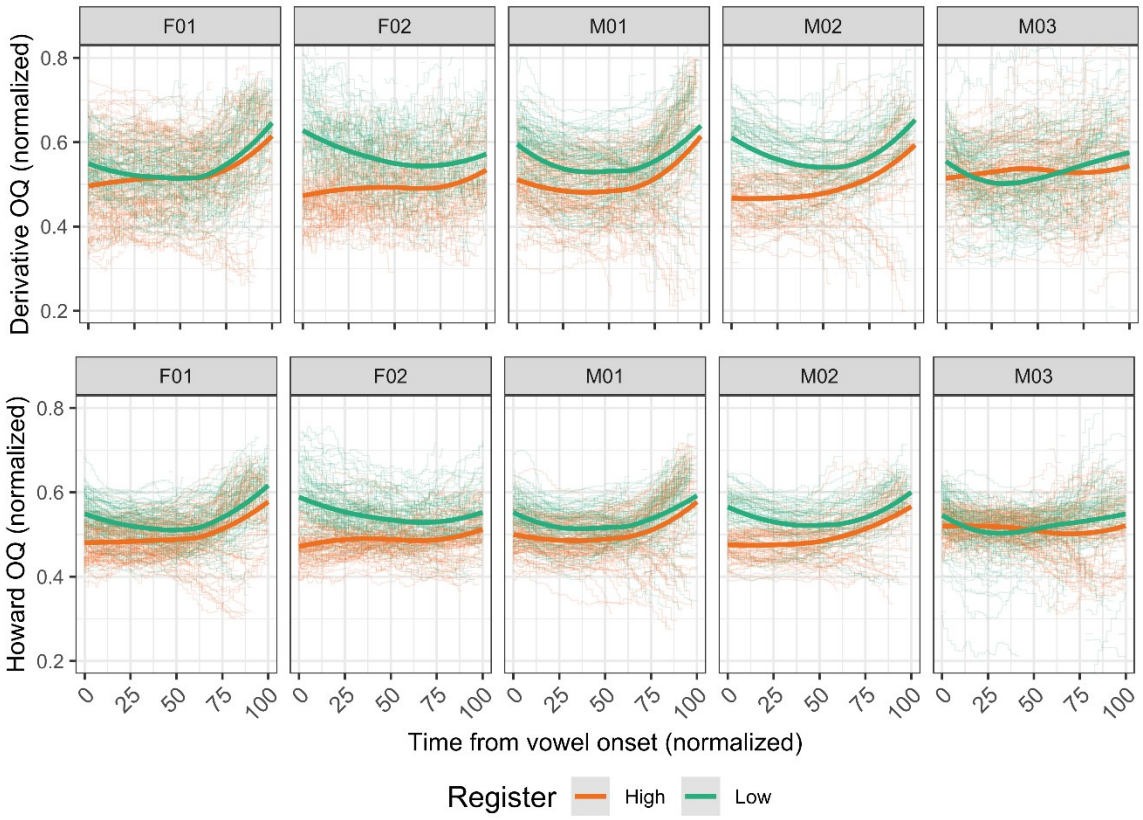


Figure 4-13. Mean OQ (open quotient) on the vowel in the low and high registers (bold lines) as measured by dEGG (derivative EGG, upper panel) and Howard (lower panel) method, by *speaker*. The thin lines represent individual OQ trajectories.

The first general pattern observed from Figure 4-13 is that for the three speakers, F02, M01, and M02, OQ is higher in the low than the high register in both OQ measurements. This OQ difference tends to diminish over vowel duration. The speaker F01 has a higher OQ in the low register than the high register for the Howard EGG but not the

dEGG results. The speaker M03 does not show a clear and consistent OQ distinction between the two registers.

Overall, the dEGG data spans over a broader range than the data measured by the Howard method, which artificially boosts the cross-register OQ difference. The two measurements are not perfectly correlated, as indicated by the OQ difference in the Howard but not dEGG results for speaker F01. A visual inspection suggests that this is largely due to double or imprecise peaks and troughs in the dEGG signal. OQ results are not entirely consistent with spectral results (H1*-H2*, CPP) either, as exemplified by the clear distinction in speaker M03's spectral results (Figure 4-8 and Figure 4-9), but not in his OQ results.

4.2.2.4 Glottal and glottalized codas and their effects on the preceding vowel

The second wordlist recorded in 2022 includes target syllables with open syllables and syllables closed by different types of codas: glottal fricative -h, glottal stop -ʔ, lateral -l, and glottalized lateral -lˀ. Figure 4-14 illustrates the vowel duration as conditioned by the varying coda types. Compared to open syllables and ʔ-ending syllables, the fricative coda -h tends to shorten the preceding vowel in all four speakers. The lateral -l conditions a longer rhyme duration than its glottalized counterpart -lˀ in two speakers, F01 and M02. The effect of the glottal stop -ʔ varies between speakers.

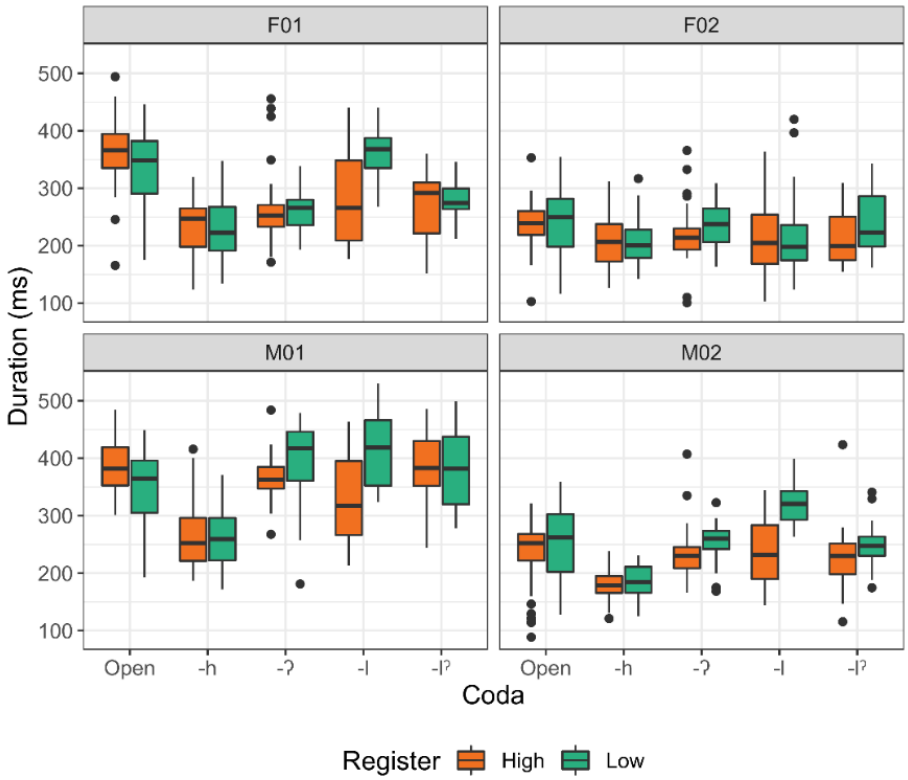


Figure 4-14. Vowel duration by different coda types, by *register* and *speaker*.

The f0 on the vowel preceding these coda types is given in Figure 4-15, and H1*-H2* in Figure 4-16. There is an overall tendency of a falling f0 in different coda contexts and speakers. However, a closer look reveals significant individual variation. For example, while F01 and F02 show a falling f0 for the syllable ending in the glottal stop -ʔ and the glottalized lateral - lʔ in both registers, M01 has a rising f0 before the glottal stop in the low register but a slight drop at the end in the high register. In the low register, M02 shows a steep f0 dip before the glottalized lateral but a rising tail before the glottal stop.

The f0 in open and l-ending syllables generally pattern similarly in all registers and speakers. The f0 before the glottal stop and the glottalized lateral is sometimes higher than that in open syllables and preceding -l (F01, M01), but it is sometimes lower (F02) or shows no clear and consistent difference (M02). Lastly, the f0 in h-ending syllables is generally

flatter and higher than the f0 in other categories due to its vowel shorting effect, but it also sometimes drops abruptly (M02, high register) due to a quick and sudden change in phonation type (Figure 4-16).

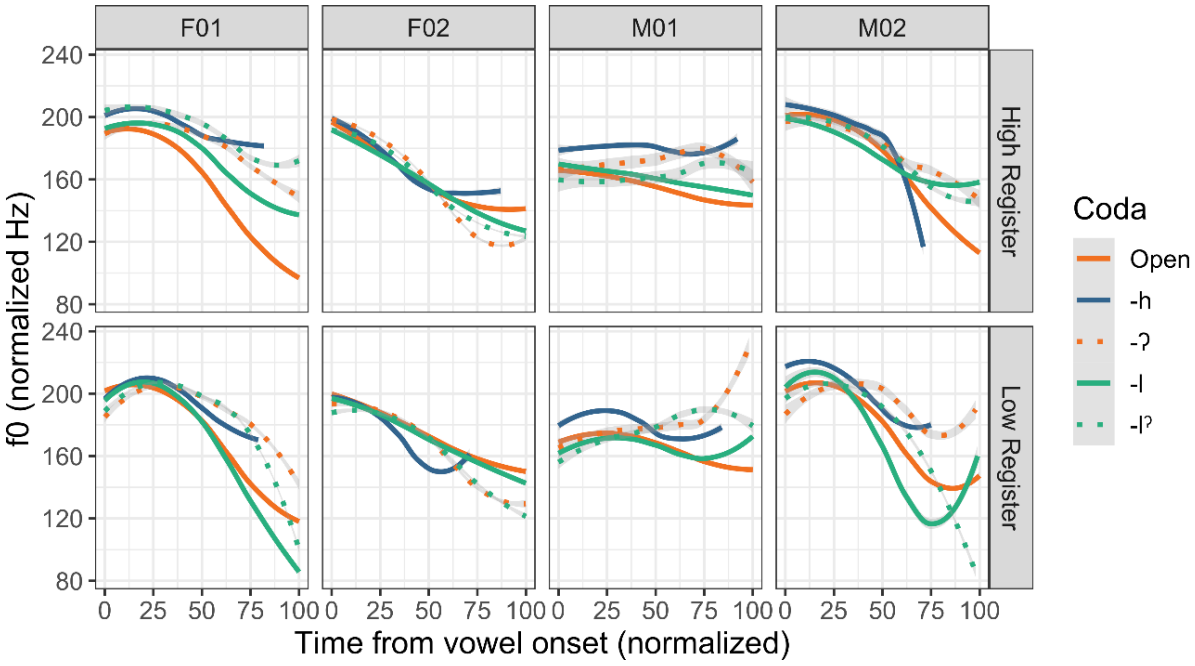


Figure 4-15. f0 on the vowel preceding different types of codas, by *register* and *speaker*.

Given the high variability of f0 in specific codas types across registers and speakers, it already seems difficult to maintain that Arem has phonologized the f0 contours conditioned by glottal/glottalized codas into tones, as claimed by previous authors (Trần, 1990; Ferlus, 2013). A more detailed discussion of this matter follows in 4.3.

Let us now turn to coda-conditioned phonation. Generally, H1*-H2* drops to the lowest level before the glottal finals -ʔ and -lʔ (Figure 4-16), although exceptions can be observed in the low register preceding -lʔ in M01 and M02 (rising instead). This indicates that the vowel is getting creakier right before these two codas. For the glottal fricative coda -h, three speakers, F02, M01, and M02 show a creakier (tense) variant in the high register and a breathier (lax) variant in the low register. Speaker F01 also follows these patterns,

although they are less distinct than in others. In short, glottal finals -ʔ and -lˀ usually introduce a creakier phonation onto the preceding vowel, but the glottal fricative -h has different variants in the two registers.

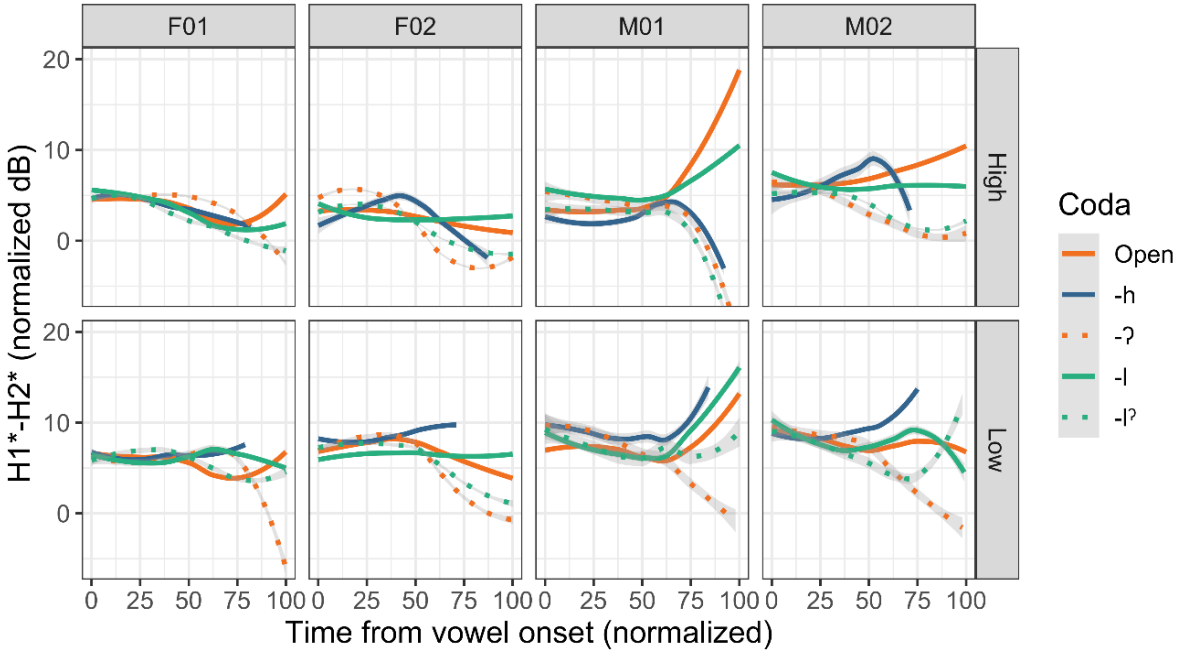


Figure 4-16. H1*-H2* on the vowel preceding different types of codas, by *register* and *speaker*.

The third wordlist consists of words combining various vowels in the two registers followed by plain sonorants /l, n, ɲ, ŋ/ or glottalized sonorants /mˀ, nˀ, ɲˀ, ŋˀ/. Only one female speaker recorded this wordlist, speaker F01 in the above sections. The f0 and H1*-H2* results of this dataset are illustrated in Figure 4-17. Syllables seem to have a longer duration when they end in plain sonorants than glottalized ones. In both high and low registers, the former has a higher f0 and a higher H1*-H2* than the latter toward their offsets. These indicate that glottalized sonorant codas condition a lower f0 and a creakier phonation than their non-glottalized counterparts.

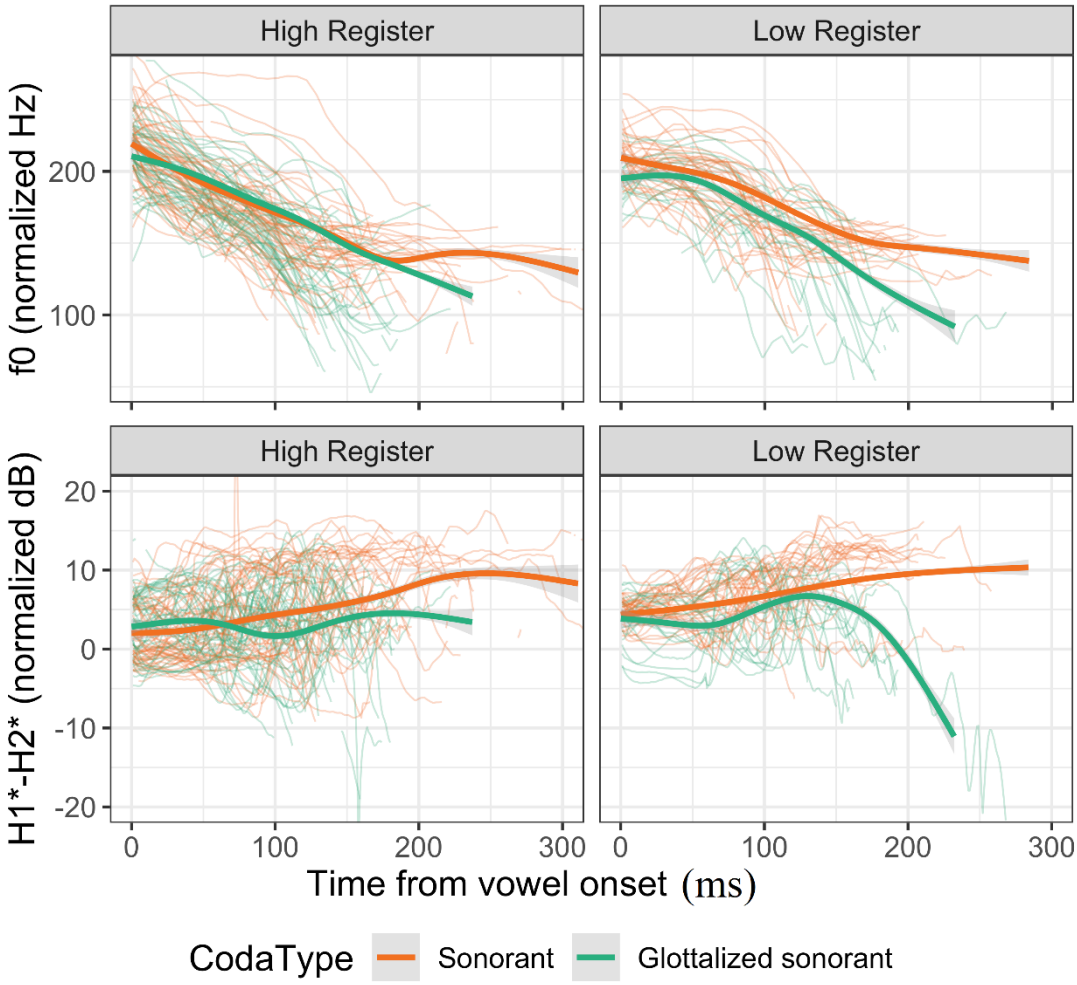


Figure 4-17. Normalized f0 (upper) and H1*-H2* on the vowel preceding plain and glottalized sonorants (bold lines), by *register,* in the production of a 40-year-old female Arem speaker. The thin lines represent individual trajectories.

Figure 4-18 gives examples of two syllables ending in /n/ and /nˀ/. One can easily note the falling f0 contour and a creaky phonation at the offset of the glottalized rhyme.

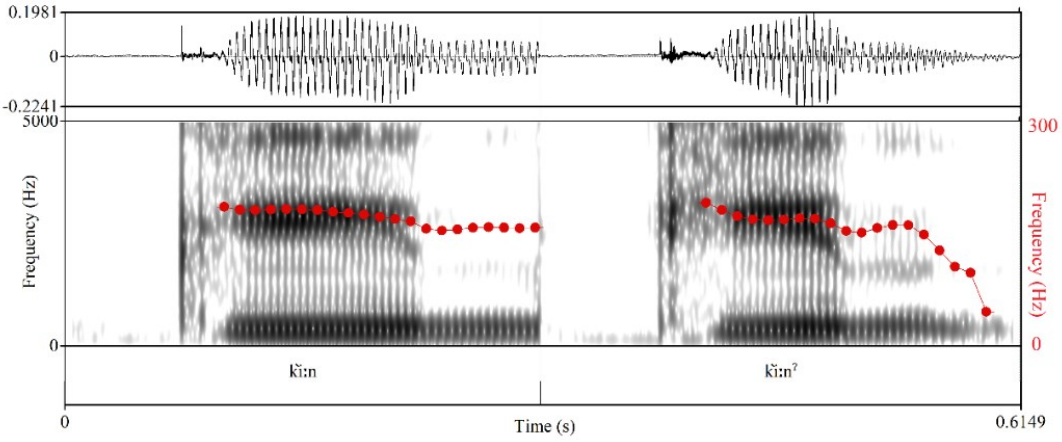


Figure 4-18. Oscillogram (upper) and spectrogram (lower) of two low-register syllables [kì:n] (in 'neck' /ukì:n/) and [kì:nʔ] 'getting water'. F0 trajectories (red dotted lines) are overlayed spectrograms.

4.3 Discussion and interim summary

The results of the production study in this chapter refute the treatment of Arem as a tonal language (Trần, 1990; Ferlus, 2013). This is because the glottal finals -h, -ʔ, and glottalized sonorants are still preserved in the language, and the duration, f0, and phonation perturbations they condition on the preceding rhyme are highly variable across registers and speakers. In particular, the fricative coda -h has both a tense and voiceless variant and a lax and partly voiced variant. This coda usually shortens the preceding vowel, leading to a generally higher and more level f0 than other coda contexts. The glottal stop -ʔ and glottalized sonorants sometimes shorten the preceding vowel but less consistently than the glottal fricative -h. These two glottal codas condition a creaky phonation toward the end of the vowel (rhyme) that is often, but not always, accompanied by a falling f0.

The results of this chapter confirm that Arem has a register contrast cued mainly by vowel quality differences and phonation type (Đoàn, 1986; Ferlus, 2013). The most distinctive property of the Arem register is vowel quality. Vowels are more closed in the

low than the high register, and the difference lasts throughout the vowel duration rather than being limited to the vowel onset as in many other register languages in the area. In practice, this means that the proto-vowel system was doubled, forming two register-conditioned subsets. Note, however, that some proto-vowels have more than one variant per register. The proto-vowel *aː, for instance, has up to five reflexes in Arem: two in the low register, /ɐ̀ː/ and /ìə/, and three in the high register, /aː, æː, ɛː/. These secondary vowel changes were partially conditioned by codas. An example is the change from high-register *aw to [ɛw] (Ferlus, 2013).

There is no f0 distinction between the high and low registers, as suggested by previous studies on Arem (Trần, 1990; Kasuga, 1994, 2008b; Ferlus, 2013). There is, however, evidence for the phonation distinction between the two registers, by which the low register has a breathier phonation. The evidence includes the spectral tilt measure H1*-H2*, the measure of the regularity of vocal fold vibrations CPP, and semi-articulatory measures of open quotient. Although there are some divergencies between phonation measurements, this register-conditioned phonation difference is consistent across speakers.

Finally, onset stops tend to have a slightly longer VOT in the low than the high register, a pattern found in many register languages (Brunelle et al., 2020; Brunelle et al., 2022a; Tạ et al., 2022). The closure duration of onsets is found to be longer in the low than the high register with the velar stop /k/, but not the coronal stop /t/.

In conclusion, the Arem tonation system is a register contrast primarily cued by vowel quality distinction and phonation type difference between a breathy (low register) and a modal (high register) phonation.

Chapter 5

Rục – A Hybrid System of Tone and Register

This chapter presents production and perception studies of the tonation system of the Rục language. I first provide some information on the Rục people and their language in Section **5.1**, focusing on previous work on the tonation system of Rục. Section **5.2** presents a production study of Rục tonation, and its results will show that the language has a hybrid system of tone and register, including four distinctive tones differentiated by f0 height, f0 contour, phonation type, vowel quality, and, to some extent, vowel duration and VOT. Therefore, Rục is the most obvious example of the intersection between register and tone in Vietic languages. Another interesting result is that syllables ending in the glottal fricative /-h/ do not show an f0 difference between the high and low registers, but rather their phonation and vowel quality differ as much as those of other pairs of low- and high-register tones. A perception study carried out to examine the perceptual prominence of the phonetic properties (focusing on open and h-ending syllables) is then presented in Section

5.3. It shows that perceptual cues roughly mirror the production properties of the tones: F1 and f0 strongly affect listeners' perception of A tones, while the most prominent perceptual cue for C tones is F1. The implications of the production and perception studies for our understanding of the tonation systems of Vietic languages are discussed in Section **5.4**.

5.1 Introduction

5.1.1 The Rục people and their language

5.1.1.1 The Rục people

Rục people live in the Minh Hoá district of the Quảng Bình province in Central Vietnam. They primarily reside in the three hamlets of Mò O Ồ Ồ, Ón, and Yên Hợp of the Thượng Hoá commune. In 2008, there were 99 households with 437 Rục people (Ban-Dân-tộc-tỉnh-Quảng-Bình, 2008, p. 16). Vietnamese authorities officially recognize Rục people as one of five groups comprising the Chứt. The other four groups are the Mày, Sách, Mã Liềng, and Arem, who reside in neighbouring areas, all in Quảng Bình province, except for a Mã Liềng group living further north in Hà Tĩnh province. The Rục dialect studied in this chapter is spoken in the Mò O Ồ Ồ hamlet. The location of this variety is marked in Figure 5-1, along with other groups of the Chứt ethnicity, each of which speaks different Vietic languages, Chứt (Rục, Mày, and Sách), Arem, and Maleng (Mã Liềng and Kha Phong). Rục is an endonym, and it means 'the start of underground water,' which suggests that these people typically resided near or along water sources emanating from caves.

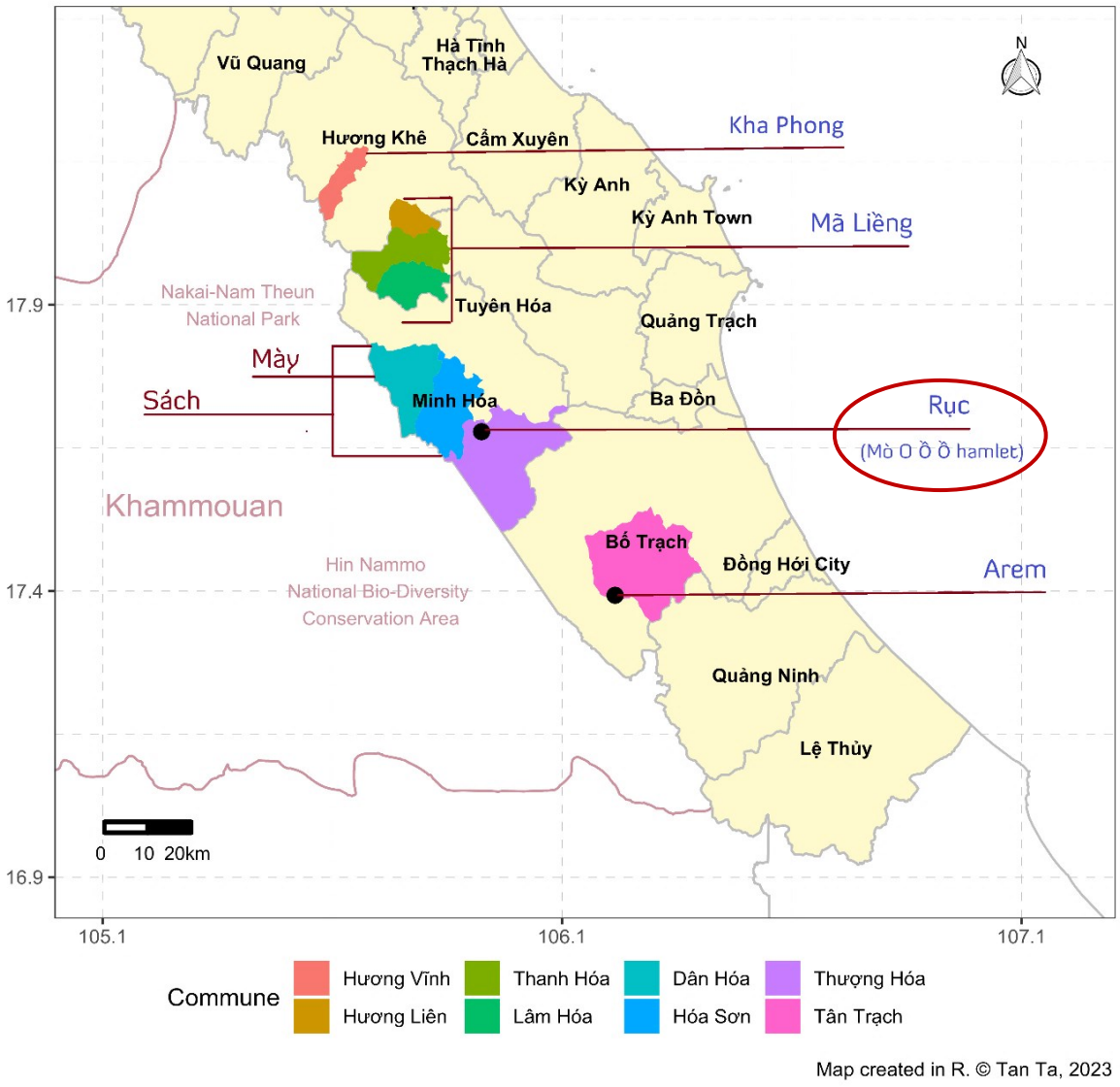


Figure 5-1. Rục-speaking community (circled) and the other two Chứt dialectal groups, Mày and Sách, along with other Vietic communities, Arem, Mã Liềng, and Kha Phong, in the provinces of Quảng Bình and Hà Tĩnh.

In the ethnographic literature, Rục people are initially known as Cha Củi or Tắc Củi people. The name Tắc Củi seems to first appear in Guinard (1911), who claims that it is the name used by Vietnamese people in Quảng Bình to refer to a group of people leading a semi-nomadic life deep inside the mountainous area of the province and only going to Vietnamese and other neighbouring villages to trade their forest products for other commodities such as salt and clothes. Tắc Củi or Cha Củi might be an exonym for these

people derived from the word /tɤkujh/ (or /tɤkkuih/), which means 'human being' in the neighbouring Katuic languages Bru, Taoi, and Pakoh (Nguyễn, 1993, p. 11). This word is also attested in other Katuic languages, like Ngeq /cakuːj/, Souei /kuaj/, Kuay /kuːj/, Pakoh /tikuaj/ and Ong /kuːj/ (SEAlang Mon-Khmer Etymological Dictionary, 2022). Since Quảng Bình is the home of many languages and dialects of the Katuic (Austroasiatic) branch, it appears that the Vietnamese have borrowed a Katuic autonym when referring to the semi-nomadic Rục (Võ, 2012).

Prior to 1960, the Rục still lived semi-nomadically in the forest in small groups of one to three households (Võ, 2012). They used caves as dwellings or built temporary foliage huts. In 1960, different small groups were persuaded to leave the forest to settle among people of other ethnic groups. At that time, even the oldest Rục people could not remember whether they had lived elsewhere before or if they had always lived in the forest of Quảng Bình. However, according to Võ Xuân Trang (2012), the so-called Nguồn people (a group of Việt-Mường speakers from the provinces of Thanh Hoá and Nghệ An, north of Quảng Bình) (Nguyễn, 1973; Võ, 2012) living in the Tuyên Hoá district (Quảng Bình province) can recall that the district was settled by sedentary Rục people more than 200 years ago. The Rục people were only forced to leave their residential area as Nguồn people migrated southward and took over their territory.

From 1960, many ethnographers and linguists, Vietnamese and foreigners (mainly Soviets), organized short field trips to the village of the "Tắc Củi" people to study their culture and language. The researchers soon discovered that these people were closely related to other Vietic groups in the area, especially with the Sách and Mày in Quảng Bình, and the endonym of Rục was used from then instead of Tắc Củi or Cha Củi. However,

determining the place of Rục in the broader linguistic and cultural ethnic tapestry was not an easy task. In 1959, the Rục people were still grouped with Mày and Bru, Khùa, Vân Kiều, Tà Ôi, even if the last four groups are nowadays clearly classified as Katuic-speaking people (Lã et al., 1959, p. 212). Vương (1963) rectified this and treated Rục, Mày, and Arem as dialects/subgroups of Sách, which he, in turn, classified as a Mường variety, and Mạc (1964) later added Mã Liềng to this Sách group. In 1973, the Rục, Mày, and Sách were finally classified as dialects of the same language, a classification that is still officially used by the Vietnamese state (Phạm, 1973; Tạ, 1973). The Arem and Mã Liềng people and their languages had not yet been investigated at that time, but these authors still grouped them with Rục, Mày and Sách under the ethnonym of Chứt (meaning 'rocky mountains' in these languages).

5.1.1.2 The Rục language

From a linguistic point of view, recent studies show that Rục, Mày, and Sách are indeed three dialects of the same language, while Arem should be better considered as a separate Vietic language. As for Mã Liềng and another local variety called Kha Phong (Kri Phọong or Maleng Kari) in the Hà Tĩnh province, they are closely related to the Maleng group, a Vietic branch mainly spoken in Laos (Trần, 1986; Ferlus, 1996, 2013; Tạ & Tạ, 2017; Babaev et al., 2021; Sidwell & Alves, 2021a).

Guignard (1911) also provided a list of basic Tắc Củi words, which he got by sending a Vietnamese person to a Sách village where the Vietnamese often traded with the Tắc Củi. These words were not directly elicited from Tắc Củi people but from a speaker of Sách, who insisted that there was not much difference between his language and Tắc Củi. Comparing the transcription of these words with later Rục lexical wordlists, it is safe to

assume that the Tắc Củi described here were indeed Rục people (Table 5-1). These would therefore be the very first Rục lexical items ever recorded[17].

Table 5-1. Some Tắc Củi words by Guignard (1911) in comparison with later Rục lexical word lists.

French	English	Tắc Củi (Guignard, 1911)	Rục (Nguyễn et al., 1988)	Rục (Nguyễn, 1993)	Rục (Solntsev et al., 2001a)
tête	head	*cu luộc*	kŭluòk	kulôok^{4}, kuluơk^{4}	kul^{u}ok^{4}
oreille	ear	*xai*	saj	saj^{1}	ɕaị^{1}
aller	go	*thì*	ti	ti^{2}	ti^{2}
eau	water	*đác*	dák	dak^{3}	dak^{3}
ventre	stomach	*cù dần*	kdəl	kudợl^{1}	ku^{ʔ}dɤ̆l^{1}
vin	wine	*cudô*	pədo	pudô^{1}	pu^{ʔ}do^{1}
porc	pig	*khŭn*	kụl	kur^{4}	kuɽ^{1}
banane	banana	*catay*	kătăj	katạj^{1}	katăị^{1}
lune	moon	*mặt plăn*	pŭl^{ə}an	pulơan^{2}	pul^{ə}an^{2}
étoile	star	*cùminh*	kŭmiŋ	kuminh^{1}	kumiŋ^{1}

The Rục people who participated in the recent study reside in the Mò O Ồ Ồ hamlet of the Thượng Hoá commune, Minh Hoá district, Quảng Bình province (Figure 5-1).

5.1.2 Rục phonemic inventory

As a Vietic language retaining many archaic features in its phonemic systems, Rục has attracted researchers' attention. Detailed linguistic wordlists and descriptions of the language include Nguyễn et al. (1988), Nguyễn (1993), and Solntsev et al. (2001a). This section

[17] Mark Alves suggested to me that these might be words from Sách people since there are few lexical differences between Mày, Rục, and Sách. However, given that Sách people have never been referred to and confused with the "Tắc Củi" group, I maintain my position here.

provides a sketch of the Rục phonemic inventory, focusing on its tonation system. This information is synthesized from the works mentioned above, but I have adapted and transcribed them in IPA based on my own data collection during two field trips to the community in 2019 and 2021.

5.1.2.1 Phonological word

Phonological words in Rục can be either monosyllabic or sesquisyllabic. Sesquisyllabic words are characteristic of many Austroasiatic languages (Thomas, 1992) and consist of two parts: a main stressed syllable exhibiting the full phonemic inventory and an unstressed presyllable that has a more restricted phonemic structure and is subject to reduction. Presyllables are highly variable between speakers. The segmental structures of mono- and sesqui-syllables are as follows:

Monosyllabic:	$C_1 (C_2) V (C_3) / T$
Sesquisyllabic:	$(C_{p1}) v (C_{p2}).C_1 (C_2) V (C_3) / T$

where C_1 is the consonant onset of the main syllable, C_2 is one of the liquids or semivowels /l, r, w/, *V* is the obligatory main vowel (monophthong or diphthong), *C3* is the coda (a consonant or a glide), C_{p1} is the onset of the presyllable, *v* is the vowel of the presyllable, C_{p2} is the coda of the presyllable, and *T* is the tone of the main syllable. The period (.) marks the boundary between the presyllable and the main syllable. Examples of some canonical Rục words are given in Table 5-2.

Table 5-2. Examples of mono- and sesquisyllabic words in Rục.

C_1 V / T	tɔː^{1}	*measuring*	laː^{3}	*leaf*
C_1 V C_3 / T	coːl^{3}	*speaking*	kuːl^{4}	*pig*
C_1 C_2 V C_3 / T	p^{h}raːw^{3}	*six*	tweːt^{4}	*parrot*
v C_1 V (C_3) / T	a.kaː^{3}	*fish*	u.raːŋ^{1}	*stick*
C_{p1} v C_1 V (C_3) / T	ka.leː^{1}	*chopstick*	pu.kuɲ^{3}	*male*
C_{p1} v C_{p2} C_1 V (C_3) / T	cəm.poː^{1}	*dream*	pən.tɛːɯ^{1}	*carry on one's head*

5.1.2.2 The presyllable

In presyllables, there are four contrastive vowels: /i, u, ɯ, a/. In fast speech, they can be neutralized as /ə/ or even dropped.

The possible onsets of presyllables are /ɓ, p, m, t, l, r, c, k, h/.

The five consonants /m, n, ɲ, ŋ, r/ are allowed as presyllable codas. These codas are usually homorganic with the main syllable onset, for example, *cə**m**.**p**oː^{1}* 'dream', *pə**n**.**t**ɛːɯ^{1}* 'carry on one's head'.

The instability and variability of the presyllable are also detectable by the fact that it could be optionally dropped or replaced by /ʔ/ preceding main syllable onsets /r, l/, or become a prenasalized part of the main syllable onset. For example, *ka.lap^{3} > ʔlap^{3}* 'shoulder', *ta.kɛŋ > ^{ŋ}kɛŋ* 'tree branch.'

5.1.2.3 The main syllable

The onset of the main syllable is a single consonant or a consonant cluster. In this position, the consonant system is at its fullest (Table 5-3).

Table 5-3. Rục onset consonants.

	Labial	*Labial-dental*	*Dental*	*Palatal*	*Velar*	*Glottal*
Plosive	p p^h ɓ		t t^h ɗ	c ɟ	k k^h	ʔ
Nasal	m		n	ɲ	ŋ	
Fricative		f v	s			h
Retroflex			ʂ	ʈ		
Trill			r			
Approximant	w			j		
Lateral			l			

Rục has 18 consonant clusters where the second position is always one of the three phonemes /r, l, w/. These clusters are in Table 5-4.

Table 5-4. Rục onset consonant clusters.

pl	pr		
p^hl	p^hr		
ɓl	ɓr		
ml		ŋw	
tl	tr	tw	
kl	kr	kw	
	k^hr	k^hw	
		hw	

The number of consonants is more restricted in the coda position, and the stops are all unreleased (Table 5-5).

Table 5-5. Rục codas.

	Labial	*Dental*	*Palatal*	*Velar*	*Glottal*
Plosive	p	t	c	k	ʔ
Nasal	m	n	ɲ	ŋ	
Fricative		s			h
Trill		r			
Approximant	w		j		
Lateral		l			

Rục has three diphthongs and nine monophthongs, out of which five monophthongs further contrast in length. However, Nguyễn (1993) claims that this vowel length contrast is gradually disappearing, a process that has been occurring across Vietic languages; for example, modern Vietnamese retains only two short vowels /ɤ, a/ (Nguyễn, 1993, p. 37). As will be clearer later, vowels are always short before the final fricative /-h/ than other codas and in open syllables. The vowel inventory of Rục in main syllables is given in Table 5-6. We will also see in §5.2.2 that these vowels start on an onglide and an offglide, conditioned by the register of the syllable.

Table 5-6. Rục vowels.

iə	ɯə	uə
iː	ɯː	uː u
eː	ɤː ɤ	oː o
ɛː	aː a	ɔː ɔ

5.1.3 The tonation system of Rục: previous studies

There have been three main descriptions of the Rục tone system. All of them are based on the auditory impressions of the authors (Nguyễn et al., 1988; Nguyễn, 1993; Solntsev et al., 2001a).

Nguyễn Phú Phong, Trần Trí Dõi, and Michel Ferlus (1988)

In the introduction to their Vietnamese-Rục-French comparative lexical list, Nguyễn et al. (1988) describe the Rục phonemic inventory, including the first systemic characterization of Rục tones. The symbols they used to encode the tones, their phonetic properties, their correspondences in Vietnamese tones, and their source(s) are summarized in Table 5-7.

Table 5-7. Rục tone system by Nguyễn et al. (1988).

Tone		*Encoding*	*Properties*	*Vietnamese correspondences*	*Alphanumeric convention*	*Source*
1	a		High tone	Ngang	A1	Native
2	à		Low tone	Huyền	A2	Native
3	ả		Glottalized rising tone	Sắc	B1	Native
4	ạ		Glottalized low tone	Nặng	B2	Native/borr.
5	á		Rising tone	Sắc	B1	Borrowed
6	a̲		Low falling tone	Nặng	B2	Native /borr.

A first point to note is that Nguyễn et al. (1988) did not treat tones in syllables ending in -h and stops (traditionally alphanumerically transcribed as C1 and C2, and D1 and D2, respectively) as separate tones. They did not explicitly mention which tones these syllables bear and did not describe their contours. They described Rục as having two tones with final glottalization (*ả* and *ạ* in their conventions, the third and fourth rows in Table 5-7. Although they did not state this explicitly, we can assume that these two tones are derived from syllables with historical final glottal stop -ʔ or glottalized rhymes. When Vietnamese words with tone *sắc*—the tone with the same diachronic origin as the Rục glottalized rising tone—are borrowed into Rục, the tone appears without final glottalization as it does in Vietnamese (*á* in their convention, the fifth row in Table 5-7).

Nguyễn et al. also claimed that out of the two tones *ạ* (glottalized low) and *a̲* (low falling), one must be the "inherited realization" in Rục, while the other is influenced by neighbouring languages, although the distinction is subtle, and it is hard to tell them apart. They seem to mean that the low falling tone (*a̲*) was borrowed from the Vietnamese *nặng* tone. However, the examples of the two tones they gave (Nguyễn et al., 1988, p. 16) seem to suggest that the variant *a̲* is present in syllables with stop codas, while the variant *ạ* in open

syllables and syllables with sonorous codas.

Along with the six tones, the authors stated that Rục has a phonemic contrast of voice-type register between "head voice register" vs. "breathy voice register" derived from the loss of voicing contrast in onsets like many other languages in Southeast Asia. They note that this breathiness is particularly clear on diphthongized vowels /ᵉɛ, ᵊʌ, ᵒɔ, ᵊa, ᵒa/, although this opening prediphthongization is not consistent in their recording. Unfortunately, the authors were unclear about which tones these vowel qualities are associated with: in their lexicon, they are present in words with both high-register and low-register tones.

Nguyễn Văn Lợi (1993)

According to Nguyễn (1993), Rục has four tones historically derived from the loss of the final glottal stop *-ʔ and the devoicing of onset stops. As the final glottal fricative /-h/ is still preserved in the language, the author treats tones in syllables ending with /-h/ as allotones of those in syllables ending in vowels or sonorants (A1 and A2). Although not explicitly mentioned by Nguyễn, tones in checked syllables (D1 and D2) seem to be treated as allotones of those derived from the final glottal stop *-ʔ (B1 and B2). According to the author, the tones of Rục with their diachronic sources and historical developments are given in Table 5-8.

Table 5-8. Diachronic sources of the Rục tones.

	Category A ***(-ϕ)***	***Category B*** ***(< *-ʔ)***	***Category C*** ***(-h/s)***	***Category D*** ***(-p/t/c/k)***
High register *(< *voiceless onsets)*	A1 (Tone 1)	B1 (Tone 3)	C1 (Tone 1)	D1 (Tone 3)
Low register *(< *voiced onsets)*	A2 (Tone 2)	B2 (Tone 4)	C2 (Tone 2)	D2 (Tone 4)

The four tones of Rục, according to Nguyễn, are differentiated by four phonological features: (i) register (f0 height), (ii) contour, (iii) final glottal stop (glottalization), and (iv) breathy phonation. The distribution of these properties in the realization of the four tones is given in Table 5-9, a modification of Nguyễn (1993, p. 30). One can note that final glottalization is a characteristic of tone B2 but not B1, although both are derived from *-ʔ. Likewise, breathy phonation is attributed to tone A2 only but not B2, despite the two tones being both in the low register derived from syllables with proto-voiced onsets. As mentioned above, the author does not treat Rục as having phonemic C1, C2, D1, and D2 tones.

Table 5-9. Phonological features of the four tones of Rục (modified from (Nguyễn, 1993: 30).

	Tone 1 (A1)	Tone 2 (A2)	Tone 3 (B1)	Tone 4 (B2)
High register	+	-	+	-
Contour	-	-	+	+
Final glottal stop	-	-	-	+
Breathy phonation	-	+	-	-

Nguyễn also provided a schematic representation of the tones, depicting their relative heights and contours. This schematization is reproduced here in Figure 5-2.

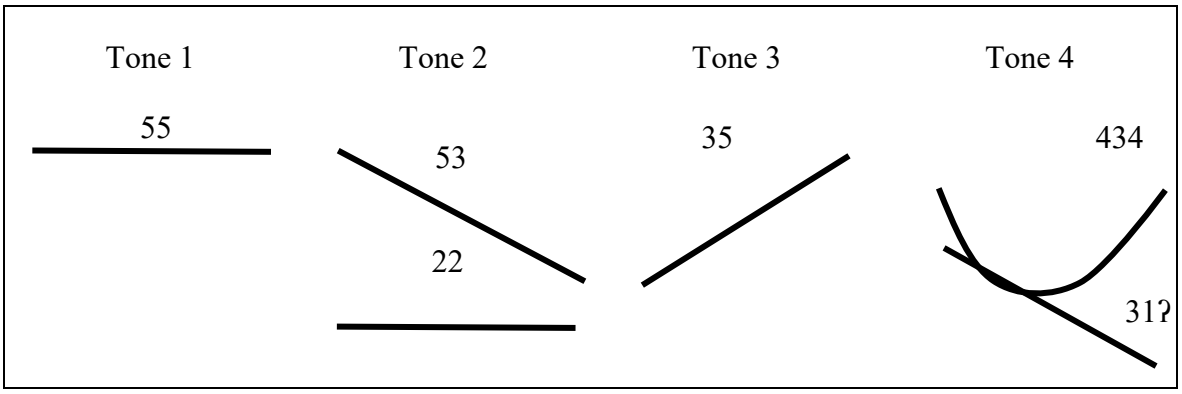


Figure 5-2. Height and contour of Rục's tone and tonal variations. The two/three-digit numbers accompanying the tone trajectories are Chao tone letters. (Figure reproduced from Nguyễn Văn Lợi (1993: 29)).

Nguyễn described the phonetic form of Rục tones as follows:

Tone 1 is a high-level tone. It has a clear voice phonation and no glottalization. The tone is situated at the ceiling of the tonal space, represented by the numeric convention 55.

Tone 2 has two variants. The main variant is a low-level tone situated at the bottom of the tonal space, represented by the numeric convention 22. This variant has a breathy phonation, contrasting with the other three tones. It is found in words that have a clear Rục origin.

A secondary variant of tone 2, which the author calls **tone 2a**, is a high-falling tone (53). This 2a variant is mainly found in words borrowed from Vietnamese with the *huyền* tone. However, Nguyễn does not mention whether this variant has breathy phonation. Neither tone 2 nor tone 2a is glottalized. Why Nguyễn treated tone 2a as a variant of tone 2 is unclear, but this could be attributed to their common diachronic origin.

Tone 3 is a middle-rising tone (35). No type of phonation or glottalization is reported for this tone.

Tone 4 has two variants, like tone 2. The main variant, found in native Rục words, is a falling-rising tone (434 contour) derived from historical ʔ-ending syllables with voiced

onsets. It has no marked phonation. The other variant (***4a***) is found in words borrowed from Vietnamese and is realized as a mid-falling tone with final glottalization (31ʔ). Nguyễn described this final glottalization as strong as a glottal stop /-ʔ/ reminiscent of the final glottalization found at the end of standard Vietnamese *nặng*. He seems to have considered this tone a variant of tone 4a because its source, Vietnamese *nặng*, has the same diachronic source as tone 4.

Besides the four phonetic characteristics mentioned above, Nguyễn (1993, pp. 36, 38) also considered the phenomenon of vowel modifications as a property associated with high- and low-register tones. Similar changes are common in Mon-Khmer languages that have developed a comparable register distinction from an initial voicing contrast in onsets (Huffman, 1976; Ferlus, 1979a). These vowel modifications are as follows.

- In syllables with high-register tones (tones 1 and 3), close vowels /iː, ɨː, uː/ are more open at their beginning and therefore have rising onglides: /iː, ɨː, uː/ > [ᵉiː, ᵊɨː, ᵒuː].
- In syllables with low-register tones (tones 2 and 4), open and open-mid vowels /ɛː, aː, ɔː, ɤː/ are more closed at their beginning and therefore have falling onglides: /ɛː, aː, ɔː, ɤː/ > [ᵉɛː, ᵊaː, ᵒɔː, ᵊɤː].

Also, note that Nguyễn did not describe the tone in syllables with the final glottal fricative /-h/ and treated them as having tones 1 (A1) and 2 (A2), depending on their historically voiced or voiceless onsets.

Solntsev et al. (Solntsev et al., 2001a)

From the same dataset obtained during the Vietnamo-Soviet linguistic expedition on Rục

in 1986 that had been partly analyzed by Nguyễn (1993), Solntsev et al. (2001a) provided a description of the Rục tone system, which is by and large in accordance with that of Nguyễn (1993) despite minor differences. For Solntsev et al., as for Nguyễn, Rục has four phonological tones, with tones 2 and 4 having variants limited to Vietnamese loanwords. The table of phonetic properties of this four-plus-two-tone system is reproduced in Table 5-10, and Figure 5-3 represents these tones in the tonal space.

From the table and figure, one can see that the main differences with Nguyễn (1993)'s description are the presence of the final laryngeal (= glottal) stop /-ʔ/ at the end of tones 3 and 4a, and the fact that tone 4 has pharyngealization[18]. As in Nguyễn (1993)'s description, breathy phonation, which Solntsev et al. called *aspirated*, is found in tone 2 only.

Table 5-10. Phonetic properties of Rục's tones (reproduced from Solntsev, Solntseva, & Samarina, 2001b: 43).

Phonetic properties		*Tone*					
		1 (A1)	**2 (A2)**	**2a (A2a)**	**3 (B1)**	**4 (B2)**	**4a (B2a)**
Final laryngeal stops		–	–	–	+	–	+
Pharyngealization		–	–	–	–	+	–
Phonation	*Aspirated (breathy)*	–	+	–	–	–	–
	Tense	+	–	–	+	–	–

[18] Although the pharynx is sometimes said to be involved in register contrasts in Southeast Asian languages (Gregerson, 1976), I am not aware of any description of pharyngealization as a tonal/registral feature in these languages. By "pharyngealization", Solntsev et al. might very well have meant "laryngealization".

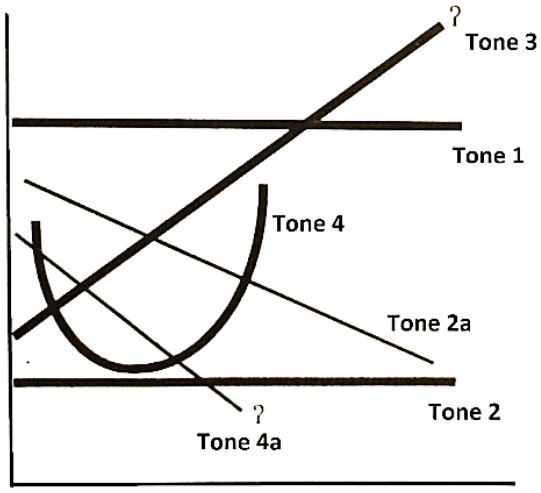


Figure 5-3. Melodic tone contours in Rục (Solntsev et al., 2001b, p. 44).

Solntsez et al. described the four tones as follows:

Tone 1 (A1 - 44) and **Tone 2** (A2 - 22) sometimes approach each other in terms of f0 height. Given that they are both level tones, they are differentiated by virtue of the breathy phonation characterizing tone 2 (no other tone and/or tonal variant has breathy phonation).

Tone 2a (31) is found in words borrowed directly from Vietnamese or Rục words pronounced under Vietnamese influence. Some words can be pronounced with both variants, but when variant **2a** is chosen, no breathy phonation or vowel modification surfaces, contrary to the main variant. For example, [kɔː^{2a}] ~ [kᵒɔː^{2}] 'stork,' [βaːŋ^{2a}] ~ [βᵊaːŋ^{2}] 'yellow.'

Tone 3 (B1 - 35ʔ) ends with a laryngeal (glottal) stop /-ʔ/, which is not the case in Nguyễn (1993)'s description of this tone.

Tone 4 (B2 - 324) is sometimes, especially at a slow speaking rate, pronounced with a middle laryngeal stop that breaks the rhyme into two parts, reminiscent of tone *ngã* in modern northern Vietnamese. This is the "pharyngealization" (more accurately,

laryngealization) feature included in Table 5-10 for tone **4**.

Tone 4a ($31^{ʔ}$) is also mainly found in words borrowed from Vietnamese or adapted to Vietnamese pronunciation. It ends in a clear glottal stop (as in tone **3**) and has a shorter duration than the other tones.

The three descriptions of the Rục tonation system summarized above disagree as to which tone has variants—tones 3 (B1) and 4 (B2) in Nguyễn et al. (1988), but tones 2 (A2) and 4 (B2) in Nguyễn (1993) and Solntsev et al. (2001a)—and as to which tone has breathy voice and final glottalization. These descriptions are helpful initial approximations for studying the Rục tonation system, but experimental studies of Rục tones are warranted.

5.1.4 Research questions

This chapter investigates the production and perception of Rục tones. It aims to answer the following research questions.

1. How are Rục tones phonetically realized in terms of f0 height, f0 contour, phonation type, vowel quality, duration, and any type of glottalization?
   - Is there any difference between the onsets of syllables with historically voiced and voiceless stops?
   - What are the characteristics of tones in syllables ending in -h?
   - How can the characteristics of Rục tones be linked to its tonogenesis and registrogenesis?
2. What are the phonetic properties Rục listeners use to perceive tones? What is the perceptual weight of each of these properties?

3. What is the link between the production and perception of Rục tones? Are there any differences between social groups and individuals?

In order to answer these questions, two experiments were conducted in the community. A production study was carried out first in the summer of 2019. This dataset was analyzed in the two following years, and some initial results were reported in Tạ (2021). These results were then used to prepare a perception study performed in the winter of 2021. During this second field trip, I also collected more production data to complement those obtained in the first trip. The production and perception studies will be presented separately below.

5.2 The production experiment

5.2.1 Method

5.2.1.1 Participants and wordlists

Twenty Rục speakers (ten men and ten women) living in Mò O Ồ Ồ (Thượng Hoá, Minh Hoá, Quảng Bình) participated in the production experiment in July 2019 (Table 5-11). They were all Rục-Vietnamese bilinguals and were more than 20 years old at the recording time. One young man and one older woman reported knowing Nguồn, a Vietic language that is genetically and geographically close to Vietnamese and Mường. One young man and one older man also know Khùa, a variety of the Bru language spoken in the Minh Hoá district. The latter (born in 1955) also knows Lao, a Tai language and the official language of Laos, thanks to his family and contacts with people on the Laotian side.

In order to investigate possible demographic differences in the phonetic realization

of tones and registers in Rục, participants were carefully recruited so that they formed a roughly balanced pool of speakers on the basis of sex and age group. Arbitrarily choosing 45 years old as a threshold resulted in four groups composed of 1) five young men (*mean* = 29.4, *sd* = 7), 2) five older men (*mean* = 56.6, *sd* = 8.4), 3) six young women (*mean* = 32.3, *sd* = 9.4), and 4) four older women (*mean* = 59.8, *sd* = 11.5)[19]. No one reported having any hearing or speaking difficulties. The speakers were compensated for their participation in the study.

Table 5-11. Rục participants in 2019.

Participant	YoB	Languages spoken
F01	1994	Rục, Vietnamese
F02	1966	Rục, Vietnamese
F03	1972	Rục, Vietnamese, Nguồn
F04	1989	Rục, Vietnamese
F05	1999	Rục, Vietnamese
F06	1986	Rục, Vietnamese
F07	~ 1975-1977	Rục, Vietnamese
F08	1950	Rục, Vietnamese
F09	1976	Rục, Vietnamese
F10	1949	Rục, Vietnamese
M01	1996	Rục, Vietnamese, Khùa
M02	1961	Rục, Vietnamese
M03	1973	Rục, Vietnamese
M04	1981	Rục, Vietnamese, Nguồn
M05	1983	Rục, Vietnamese
M06	1955	Rục, Vietnamese, Khùa, Lao
M07	1994	Rục, Vietnamese
M08	1994	Rục, Vietnamese
M09	1955	Rục, Vietnamese
M10	1970	Rục, Vietnamese

[19] It needs to be mentioned that one woman (F07) did not know her year of birth but judging from her appearance and her relationships to other people in the community, she was grouped into the young female group. Many Rục people do not know their ages, as their grandparents and parents did not record time in consecutive years when they still lived in forest.

I compiled a wordlist of 66 lexical items (Appendix 5-1), which contain syllables combining five vowels /iː, ɛː, uː, ɔː, aː/, four onsets /p, t, k, l/ and four tones, A1, A2, B1, and B2. These target syllables were either monosyllabic words or the main syllables of sesquisyllabic words. Words with open syllables (ending in vowels) were preferred, and when they were not available, words ending in the glide /j/ or the nasal or lateral segments /m, n, ŋ, l/ were chosen. The wordlist also includes some words with final stops to fill in accidental gaps in the vowel-tone-onset combinations. I also included four words ending in the final fricative /-h/ with the vowel /a/ to investigate the characteristics of tone/register in this context.

An initial analysis (Tạ, 2021) of the first wordlist showed that tones in syllables ending in /-h/ are phonetically distinct from the two tones A1 and A2, of which they are traditionally considered allophonic variants. As this unexpected difference can shed new light on our understanding of tonogenesis and registrogenesis, I went back to the Rục community in October 2021 to record more words ending in /-h/. This was also an opportunity to record more open syllable words to complement the initial results obtained in (2021) showing that different types of synchronic onsets (different manners and places of articulation of the four onsets /p, t, k, l/) do not condition tonal/registral differences. This second wordlist contains 12 words ending in /-h/ and 38 words ending in vowels (without controlling for onsets) (see Appendix 5-2). Note that there are no words with the vowels /iː, ɛː/ and the low register tone C2 due to systematic gaps. The second wordlist also contained some open-syllable words identical to those in the first wordlist recorded in 2019.

After the perception experiment (Section 5.3), seventeen[20] speakers agreed to record the second wordlist, including four younger males (*mean* = 24.5, *sd* = 3.8), five older males (*mean* = 56, *sd* = 7.2), five younger females (*mean* = 26.3, *sd* = 4.5), and three older females (*mean* = 48.8, *sd* = 4.3). These include some speakers who participated in the experiment in July 2019 (two young males, three old males, three young females, and one old female). The speakers were compensated for their contribution to the experiment.

Besides these two main wordlists, thirteen participants agreed to record a third, shorter wordlist right after completing the perception experiment. These recordings were meant to compare specific participants' production and perceptual weights. This list included eight words (Appendix 5-3) in the production analysis.

Information about Rục participants who took part in the 2021 experiments is given in Table 5-12.

Table 5-12. Rục participants in 2021.

Participant	YoB	Languages spoken	Participated in 2019	Perception experiment completion	Recorded the 2nd wordlist	Recorded the 3rd wordlist
M01	1955	Rục, Vietnamese, Khùa, Lao	✓	✓	✓	
M02	1961	Rục, Vietnamese		✓	✓	
M03	1965	Rục, Vietnamese Nguồn	✓	✓	✓	
M04	1959	Rục, Vietnamese		✓		
M05	1996	Rục, Vietnamese		✓		
M06	1993	Rục, Vietnamese		✓		
M07	1992	Rục, Vietnamese				
M08	2003	Rục, Vietnamese		✓	✓	✓
M09	1992	Rục, Vietnamese				
M10	2003	Rục, Vietnamese		✓		
M11	1969	Rục, Vietnamese		✓	✓	

[20] Data from two other older males were excluded before annotating as they had many hesitations and disruption during recording sessions.

M12	1971	Rục, Vietnamese	✓	✓	✓	
M13	1996	Rục, Vietnamese	✓	✓		
M14	1971	Rục, Vietnamese		✓		✓
M15	1959	Rục, Vietnamese		✓		✓
M16	1994	Rục, Vietnamese	✓		✓	
M17	2000	Rục, Vietnamese		✓		✓
M18	2003	Rục, Vietnamese		✓		✓
M19	1992	Rục, Vietnamese				
M20	1995	Rục, Vietnamese			✓	
M21	1994	Rục, Vietnamese	✓		✓	
				✓		
F01	1996	Rục, Vietnamese		✓		
F02	1995	Rục, Vietnamese		✓	✓	✓
F03	1997	Rục, Vietnamese		✓		
F04	1994	Rục, Vietnamese				
F05	1994	Rục, Vietnamese	✓	✓	✓	✓
F06	2000	Rục, Vietnamese		✓		
F07	1987	Rục, Vietnamese	✓	✓	✓	✓
F08	1949	Rục, Vietnamese	✓			
F09	1962	Rục, Vietnamese		✓		
F10	1972	Rục, Vietnamese	✓	✓	✓	
F11	1999	Rục, Vietnamese		✓		
F12	1989	Rục, Vietnamese		✓	✓	✓
F13	1976	Rục, Vietnamese		✓	✓	
F14	1950s	Rục, Vietnamese		✓		✓
F15	1975	Rục, Vietnamese		✓		✓
F16	1975	Rục, Vietnamese		✓	✓	✓
F17	1975	Rục, Vietnamese		✓		✓
F18	2000	Rục, Vietnamese			✓	

5.2.1.2 Recording

I read target words in Vietnamese to the Rục participants and asked them to translate and pronounce them in a frame sentence:

ho:^{A1} co:l^{B1} sje:ŋ^{B1}___ la:j^{B2} tɤ:k^{B1} pani:^{A1} (ca)maŋ^{A1}

I say sound ___ again for you (pl.) hear

'I say the word ___ again for you to hear.'

The three wordlists were all recorded four times, and the items were randomly ordered at each iteration. Recordings were made in the same wooden house in the community on both field trips. The recording sessions were sometimes disrupted by strong winds blowing through the valley where the Rục village was located or by noise from domestic animals. In these cases, the affected recording tokens were replaced by asking the speakers to repeat them one more time. Recording sessions took 25 – 40 minutes per speaker for the first two wordlists and 5 minutes for the last.

In the summer of 2019, a high-quality sound channel was obtained with a Shure Beta53 headset. A Rothenberg EG2PCX electroglottograph was also used to record three signals: an EGG channel, a larynx height tracker, and a second audio signal used for synchronization purposes (cf. Chapter 4). The second sound channel was recorded using a Behringer ECM8000 microphone connected to the EG2PCX. All four signals were recorded on a Macbook running the SpeechRecorder application through a Steinberg UR242 preamplifier.

In the winter of 2021, only two audio channels were recorded: one with the same Shure Beta53 headset and another with a Beyer Dynamics M500 TG, both connected through the same Steinberg UR242 amplifier to a Macbook running SpeechRecorder.

The high-quality audio signals recorded with the Shure Beta53 during both field trips will be incorporated and reported together. The EGG data in the first trip will be analyzed and reported in a section about semi-articulatory results. As in Chapter 4, the larynx tracking data will not be reported.

The merging of the two datasets collected in 2019 and 2021 unavoidably causes some drawbacks, such as minor differences in equipment settings, changes in individuals'

voices over time (two years), and unbalanced numbers of tokens across speakers. This is exemplified by Figure 5-4, which represents f0 tracks for the six tones in the production of four speakers who recorded the two long wordlists.

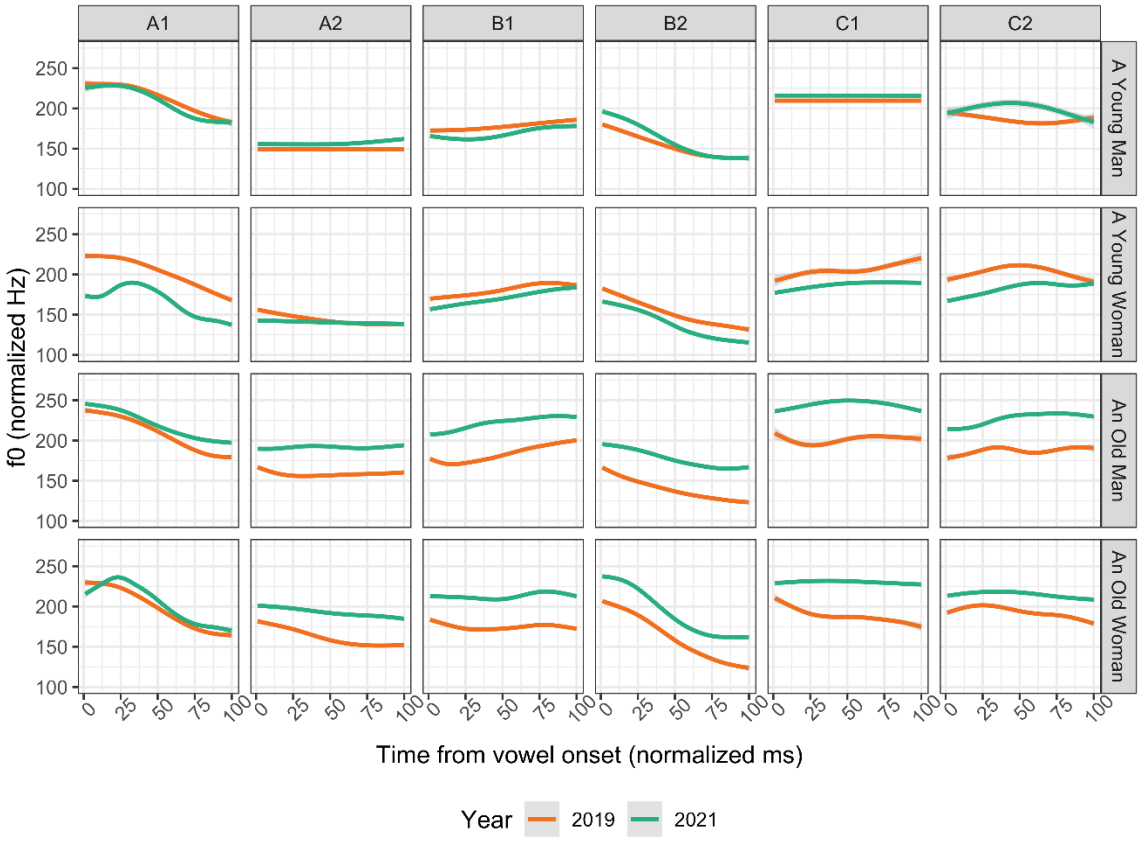


Figure 5-4. The six tones of Rục in the production of a man born in 1994 (younger man), a man born in 1955 (older man), a woman born in 1994 (younger woman), and a woman born in 1972 (older woman) in the two years of 2019 and 2021.

For two younger participants (*upper rows*), the f0 height and contour of each tone are roughly identical across the two years of recording. For the two older participants (*lower rows*), except for the high-register tone A1, tones in 2021 have a higher f0 than in 2019, although their contours are the same. This turned out not to be problematic because almost every tone was raised in f0, thus maintaining the relative differences between the two tones in each tonal category (A, B, C). Figure 5-5 shows Cohen's *d*s, a measure of the

separateness between the two tones in each category, for six phonetic properties of Rục tones in the production of the seven speakers who recorded both wordlists in 2019 and 2021 (more in §5.2.3). Except for speaker F05 (a young woman), speakers do not show large changes in Cohen's *d*s, suggesting that the extent to which the high and low registers were differentiated over two years was relatively stable.

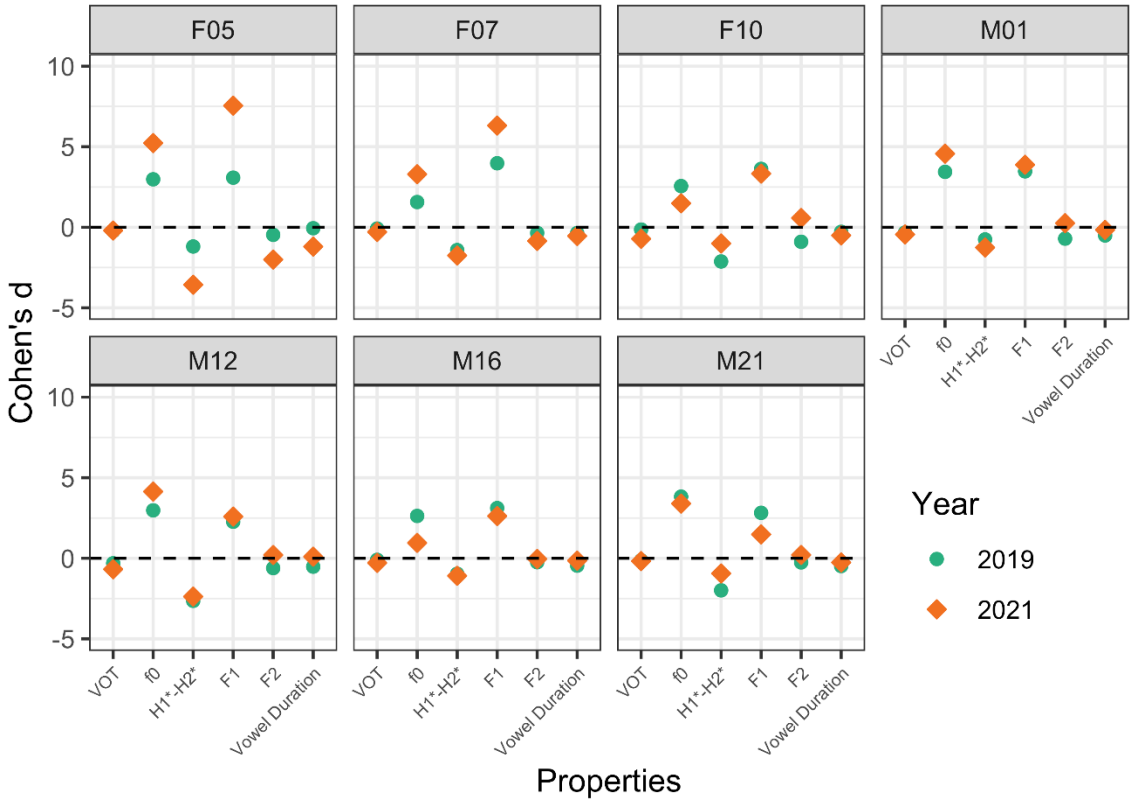


Figure 5-5. Cohen's *d* scores of phonetic properties in the production of speakers recorded two wordlists in 2019 and 2021.

I, therefore, decided that the advantages of combining the three sets of recordings outweighed the drawbacks. To further minimize the detrimental effects of using several wordlists, two measures were taken: (i) treating a participant's recordings as belonging to separate levels of the *speaker* factor if they were made in different years, and (ii) always including *speaker* and *word* as random effects in statistical models.

5.2.1.3 Data annotation and processing

A number (84) of tokens had to be excluded due to uncontrolled background noise (wind gusts, domestic animals, vehicles), disfluencies and confusion in target words. The remaining 4579 tokens were annotated in Praat TextGrids. Data extraction, cleaning, and normalization were performed following the same procedure as in Chapter 4. In the end, I had to exclude 5% of f0 measures, 3.1% of F1 measures, 4.8% of F2 measures, 7.5% of H1*-H2*, 7.5% of H1*-A1*, 10.9% of H1*-A2*, 8.1% of H1*-A3* measures, 4.9% of EGG-based Howard threshold OQ, and 8% of dEGG-based OQ measures.

5.2.1.4 Statistical modelling

In order to test for potentially significant effects of contextual factors (*tone, vowel, onset*) and demographic factors (*sex* and *age)* on the phonetic and semi-articulatory properties of tone/register in Rục, GAMMs (generalized additive mixed models) (Wood, 2006) were built for each of the properties using the R package *mgcv (*Wood & Wood, 2015*)*. The reason for choosing GAMMs over other types of statistical modellings is that (i) it provides non-linear estimations of time-varying data (smooths), like f0, F1, F2, H1, H2, CPP, other spectral measurements, and OQ, and (ii) it nicely handles the issue of auto-correlation inherent to time-varying data (Wood, 2006; Baayen, van Rij, de Cat, & Wood, 2018).

As the focus of this chapter is on differences between tone/register in terms of phonetic and semi-articulatory properties, the fixed factor in every GAMM will be *Tone.* By-subject and by-word random smooths will also be included in models to account for the random effects of speakers and lexical items. If the compounding effect of *Tone* with contextual factors (*vowel, onset*) and social factors (*sex, age*) are of interest, the interactions between these properties and *Tone* will be created and included in models as both intercepts

and smooths. Until now, this is the only known method to handle with interactions of factors in GAMMs (Tremblay & Newman, 2015; Desmeules-Trudel & Brunelle, 2018; Ünal-Logacev, Fuchs, & Lancia, 2018; Wieling, 2018; van Rij et al., 2019; Tabain & Beare, 2020; Tạ et al., 2022; Kirby, Pittayaporn, & Brunelle, 2023). An example of a GAMM designed to investigate the effect of *Tone* on the F1 realization of Rục vowels is given below:

```
F1 ~  Vowel_Tone +
      s(Time, by= Vowel_Tone) +
      s(Time, Word, bs="fs", m=1) +
      s(Time, by = Subject, bs="fs", m=1), data=..., rho=...,
      AR.start=...$start.event, family= "scat")
```

Throughout this dissertation, whenever GAMMs are used, autocorrelation and scattering distributions of the data are handled with built-in variables in *gam* or *bam* functions of the *mgcv* package (Wood, 2006; Wood & Wood, 2015; Baayen et al., 2018; Wieling, 2018; Tạ et al., 2022). In all GAMM-predicted panels in the figures that follow two or any number of time-series data trajectories are said to significantly differ from each other at any given time point if their 95% confidence intervals (CIs) do not overlap. This is a straightforward and intuitive interpretation of the statistical results that GAMMs offer. When GAMM-predicted difference between two categories is used instead, it is said to be significant if its CI does not touch the x-axis.

As will be clear later, Rục tones are usually differentiated by large differences in f0, phonation, and vowel quality. Therefore, GAMMs will only be used when needed, i.e., when some differences between categories are not robust and need to be tested statistically.

For non-time varying data such as VOT, closure duration, and rhyme duration, generalized mixed-effect models fitted with the R package *lmer* (Kuznetsova et al., 2017) were used. By-subject and by-word random intercepts were included in the models. The

maximal models include fixed factors of *register, vowel, place of articulation*, and all their two-way interactions. The optimal one is the result of the model simplification procedure described in Chapter 4.

5.2.2 Results

5.2.2.1 Consonantal properties

It is usually found that in register languages, devoiced voiced stops have a slightly longer VOT than their historically voiceless counterparts (Brown, 2020; Brunelle et al., 2020; Tạ, Brunelle, & Brown, 2020; Brunelle & Tạ, 2021; Brunelle et al., 2022a; Tạ et al., 2022). It is also cross-linguistically attested that voiced stops have a shorter closure duration than voiceless stops (Lisker, 1957; Lehiste, 1970; Shen, Wooters, & Wang, 1987; Gao, 2015). As voiced stops in Rục presumably devoiced, leading to the formation of low-register tones, one could expect that this onset series still retains some remnants of VOT and exhibits closure duration differences compared to the unchanged voiceless stops. This section reports the results from the first wordlist as it was controlled for onsets.

Voice onset times

Figure 5-6 provides the VOT distribution of Rục onset stops grouped by *tone* and *place of articulation.* Tones are further grouped by their tonal etymologies—their original onset voicing and laryngeal finals. These VOT values are almost all positive, which is expected since voiced onsets in the language were presumably devoiced.

Two major patterns can be observed from these distributions. Firstly, onsets in syllables with low-register tones (A2, B2, C2) seem to have longer VOTs than their high-register counterparts (A1, B1, C1). Secondly, there are few tokens with closure voicing

(negative VOTs), especially for the main syllable onset /p/ of the word /lapu^{A2}/ 'gourd' (top-left panel), which was usually implosivized under the influence of the Vietnamese cognate /ɓuː^{A2}/.

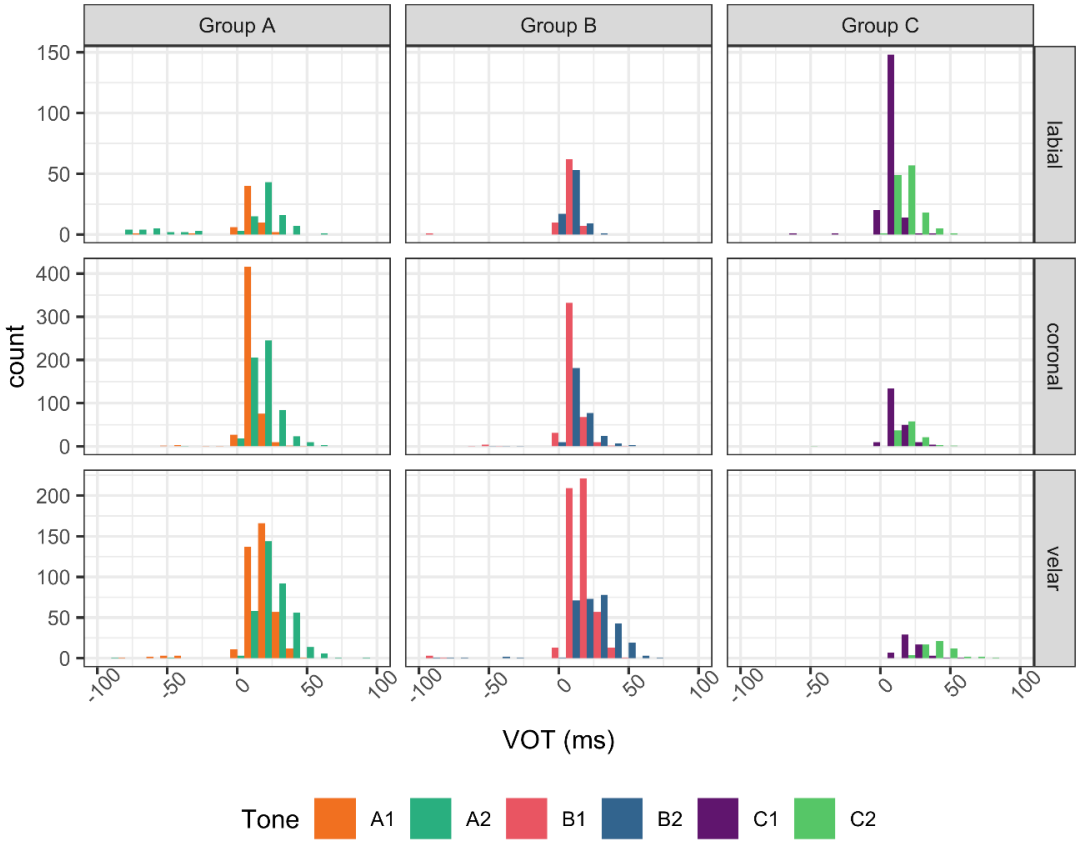


Figure 5-6. VOT distributions of onset stops in Rục by *tone* and *place of articulation*. Tones are further paired by their etymological sources. Some observations with VOT smaller than -100 ms were truncated, and different scales were used for the three PoAs to facilitate visual inspection.

Table 5-13 reports the number of observations, mean values, and standard deviations for VOT in each category. Generally, standard deviations are high due to individual variation. VOTs in the low-register tones, A2, B2, and C2, are always higher than in their high-register counterparts at all three places of articulation. Within each tone, the further back the articulation, the longer the VOT, which is universally expected (Fischer-Jørgensen, 1954; Peterson & Lehiste, 1960; Cho & Ladefoged, 1999).

Table 5-13. Average VOT values (in bold) of onset stops in Rục by *tone* and *place of articulation*. The number of tokens is italicized, and standard deviations are in parentheses. The high standard deviation of A2 at the bilabial place (shaded cell) was due to implosive readings of the word /lapu:^{A2}/.

	A1	A2	B1	B2	C1	C2
Bilabial	*60* **9.5** (13.3)	*108* **2.7** (38.3)	*80* **7.8** (11.3)	*80* **8.6** (5.3)	*186* **9.4** (7.3)	*131* **18.7** (7.9)
Coronal	*539* **10.4** (7.6)	*590* **18.5** (9.9)	*450* **10.3** (9.1)	*305* **14** (10.2)	*208* **13** (7.2)	*122* **19.2** (11)
Velar	*393* **16.4** (13.1)	*379* **24.8** (16.8)	*519* **16** (15.1)	*295* **24.3** (17.3)	*58* **24.4** (8.8)	*59* **40.4** (11.6)

In order to see if VOT differences are statistically significant, linear mixed-effect models were fitted to the VOT data. The VOT data of the word /lapu:^{A2}/ was excluded before running the models. The optimal model includes binary interactions between *vowel* and *register* and *place*. The summary of the model is given in Table 5-14. These statistical results confirm that onset stops in the low register have a significantly longer VOT compared to the baseline of the high register. VOT is also significantly longer in velars than in the bilabial baseline. However, the VOT difference between bilabial and coronal places is not significant. One interaction between the vowel /ɔ:/ and the coronal place also shows a significant effect.

Table 5-14. Results summary of the optimal linear mixed-effects model fitted to the VOT data in Rục. Model: *VOT ~ Register * Vowel + Place * Vowel + (1|Speaker) + (1|Word)*

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	**8.07**	**2.40**	**39.22**	**3.37**	**0.00*** **
RegisterLow	**7.21**	**2.24**	**35.35**	**3.22**	**0.00****
Vowele	6.61	4.48	37.80	1.48	0.15
Voweli	-1.87	4.00	35.23	-0.47	0.64
Vowelo	3.88	3.57	36.01	1.09	0.28

Vowelu	1.95	3.90	35.83	0.50	0.62
Placecoronal	3.68	2.68	35.18	1.37	0.18
Placevelar	**9.79**	**3.08**	**35.65**	**3.17**	**0.00****
RegisterLow:Vowele	-7.09	3.83	36.40	-1.85	0.07
RegisterLow:Voweli	7.00	4.66	35.72	1.50	0.14
RegisterLow:Vowelo	-0.40	3.84	35.83	-0.10	0.92
RegisterLow:Vowelu	1.07	4.08	35.66	0.26	0.79
Vowele:Placecoronal	-7.72	4.95	37.99	-1.56	0.13
Voweli:Placecoronal	2.23	4.66	36.79	0.48	0.63
Vowelo:Placecoronal	**-8.18**	**4.09**	**36.01**	**-2.00**	**0.05***
Vowelu:Placecoronal	-2.43	4.36	35.77	-0.56	0.58
Vowele:Placevelar	-10.54	5.30	37.13	-1.99	0.05

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

There are 71/4562 tokens (1.6%) with negative VOTs in the onset stop dataset: the vocal folds vibrate during their closure. Out of these, the implosivization of the onset /p/ in the word *lapu*^{A2} 'gourd' accounts for 22 cases. In most other cases, closure voicing carries over from the previous sonorant, as illustrated in Figure 5-7. This passive closure voicing mostly happens when the speaker pronounces the frame sentence without pauses or hesitations, and it is especially prevalent in speaker M08_2019, who accounts on his own for 16/71 tokens. Note that the distribution of these prevoiced onsets, which are given in Appendix 5-4, does not seem attributable to intervocalic voicing in sesquisyllables: the medial onsets of the only two sesquisyllabic words, *kətuːm*^{B1} 'gather' and *təkiː*^{B2} 'neck,' do not have more negative VOT tokens than the monosyllabic words. Based on the data in Appendix 5, closure voicing does not appear more common in words with low-register than high-register tones.

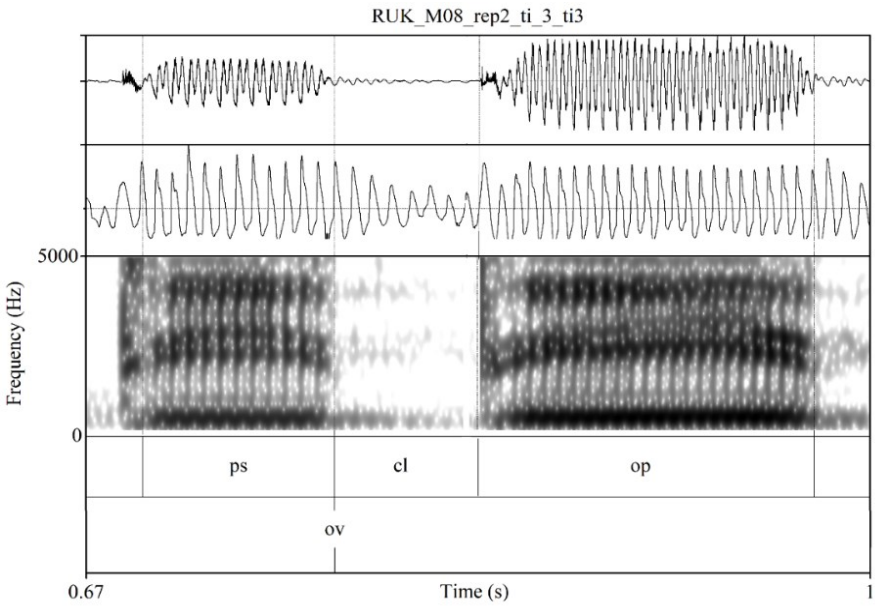


Figure 5-7. An example of voiceless onset with closure voicing due to the continuous vibration of the vocal folds throughout the closure in the production of speakers having fast and fluent speech. Top panel: oscillogram, middle panel: EGG signal, and bottom panel: spectrogram.

Closure duration

Figure 5-8 illustrates the closure duration of the three onset stops /p, t, k/ as conditioned by the six tones. The only noticeable pattern from the figure is the seemingly overall shorter closure duration in the velar onset /k/ than the two other onsets /p, t/, which is attested cross-linguistically (Lisker, 1957; Lehiste, 1970; Shen et al., 1987; Gao, 2015).

Within each tone group, there does not seem to be a consistent closure duration difference between the low-register and the high-register tones at either of the three points of articulation. This is statistically confirmed by the absence of the *register* factor in the optimal linear mixed-effects model fitted to the closure duration data (Table 5-15). The model results also confirm the above-mentioned shorter closure duration in velars compared to the bilabial baseline. There is no significant difference between labials and coronals in their closure duration.

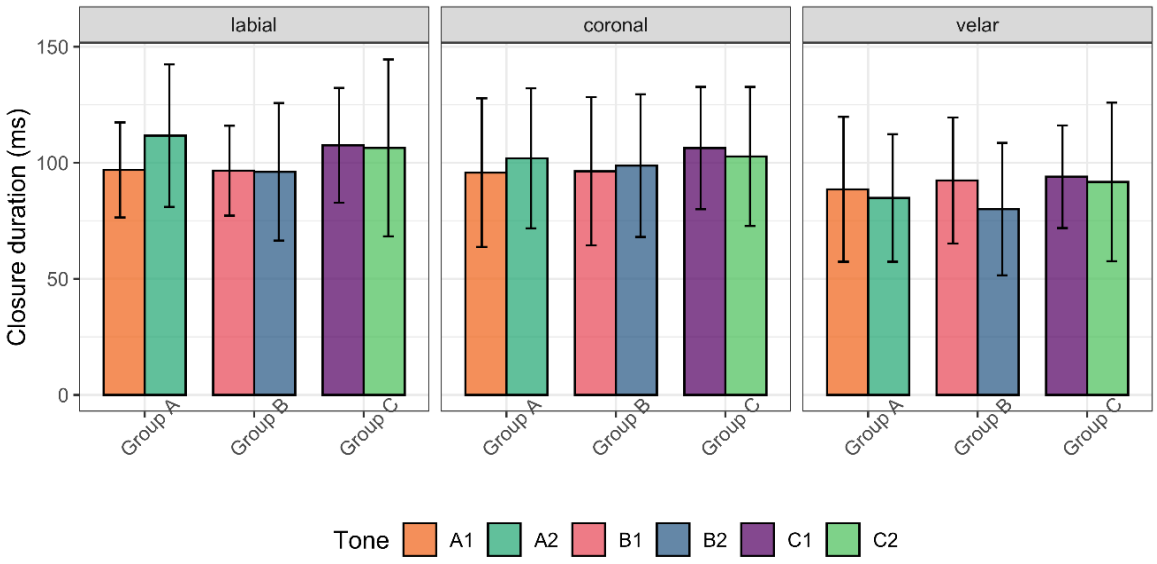


Figure 5-8. Closure duration by *tone* and *PoA*. Tones with the same source of historical laryngeals (groups A, B, and C) are juxtaposed.

Table 5-15. Results summary of the optimal linear mixed-effects model fitted to the closure duration data. Model: *closure_duration ~ Place + (1|Subject) + (1|Word)*

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	**105.72**	**4.25**	**88.65**	**24.86**	**0.00*** **
PlaceCoronal	-2.82	4.01	53.80	-0.70	0.48
PlaceVelar	**-13.91**	**4.06**	**52.81**	**-3.42**	**0.00****

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

5.2.2.2 Vocalic properties

Except for the comparison of raw rhyme duration, time-sensitve data in this section were normalized by multiplying the 100-interval scaled time by the grand mean duration of each tone.

Fundamental frequency

Figure 5-9 illustrates the mean f0 of the six tones of Rục on rhymes over all target syllables, repetitions, and speakers.

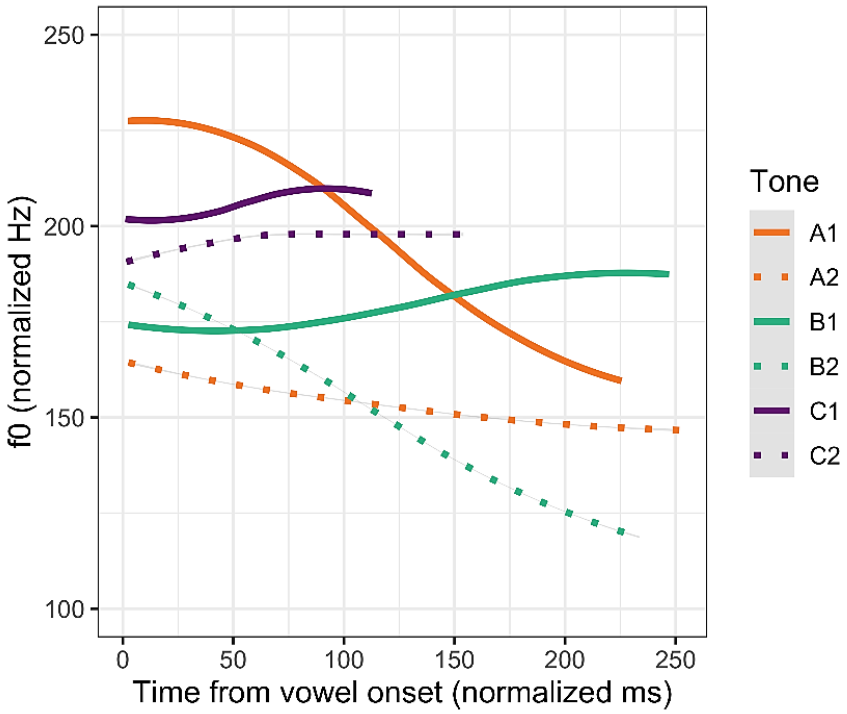


Figure 5-9. Mean f0 of Rục six tones across target syllables, repetitions, and speakers.

The first impression one gets from Figure 5-9 is that Rục tones differ in both f0 height, f0 contour, and duration. However, the f0 trajectories of C1 and C2 are quite close to each other. In order to see if there is any statistically significant f0 difference between C1 and C2, GAMMs were fitted to the f0 data of these two tones. The GAMM-predicted f0 difference between these two tones is given in Figure 5-10. It confirms that C1 and C2 are not significantly distinct from each other in f0.

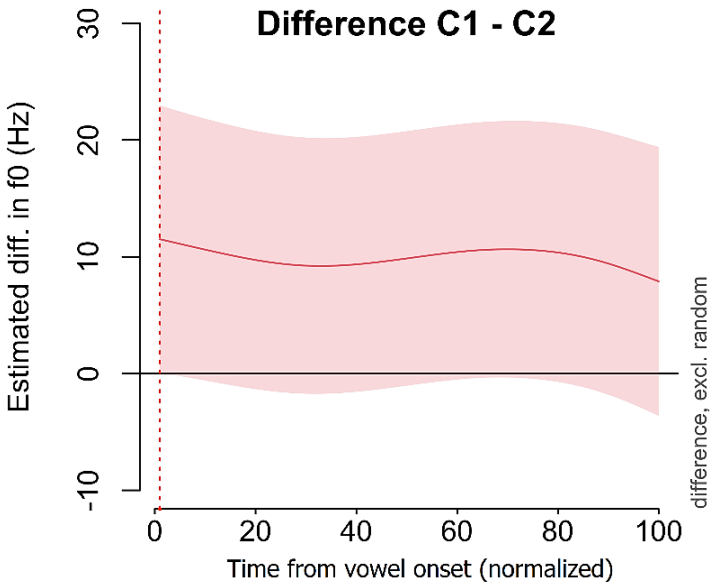


Figure 5-10. GAMM-predicted f0 difference between C1 and C2. The difference is not significant, as shown by the ribbon representing the 95% confidence interval touching the x-axis.

The f0 characteristics of Rục tones can be summarized as follows:

- **A1** is the falling tone with the highest onset and the steepest decline. A1 is significantly higher than its low-register counterpart, A2, throughout their time course.
- **A2** is also a falling tone. Compared to A1, A2 has a lower starting point and experiences a more gradual f0 change toward its end.
- **B1** is a mid-rising tone with a more stable f0 height at its onset and offset.
- **B2** is a mid-falling tone. Its falling slope is comparable to that of the A1 tone.
- **C1** and **C2** are both level tones and have the overall highest f0 of all the tones, although their first third is lower than the falling contour of the A1 tone. The f0 height difference between the two is not significant.

The duration differences between tones will be investigated later in this section.

Phonation type

Figure 5-11 represents H1*-H2* (left panel) and CPP (right panel) of the six tones of Rục across target *words*, *repetitions*, and *speakers*. The H1*-H2* differences between the tones seem to be largest at their onsets and gradually diminish toward their midpoints. There is a rough binary grouping between the high-register and low-register tones. The low-register tones have higher H1*-H2* values than the high-register tones, indicating a breathier phonation type. Among the three tone pairs, the H1*-H2* difference between C1 and C2 is the highest, nearly 6 dB, compared to 3.5 dB differences between A and B tones. Last but not least, C1 and C2 tones have rising and very high H1*-H2* values towards their offsets, A1 and A2 tones are intermediate, and B1 and B2 tones have the lowest H1*-H2*. These patterns are expected due to the regressive effect of the final fricative on the preceding vowel in C tones and the fact that B tones originally ended in a glottal constriction.

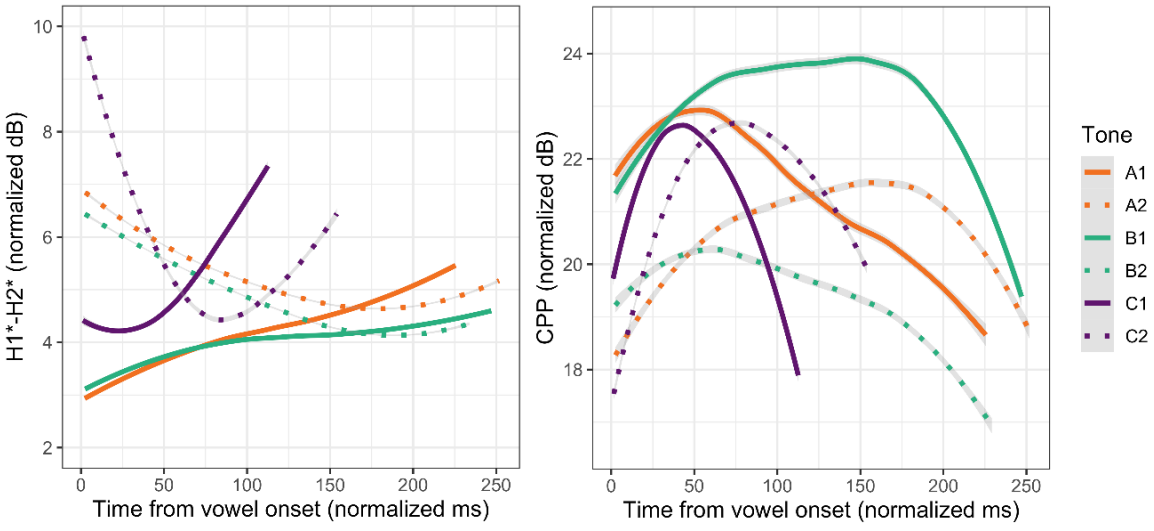


Figure 5-11. Mean H1*-H2* (left) and CPP (right) of the six Rục tones across target words, repetitions, and speakers.

The CPP results (right panel in Figure 5-11) are largely in accordance with the H1*-

H2* results, albeit the CPP values go in the opposite direction: a higher CPP indicates a more modal phonation. The two registers are distinguished by a modal phonation in the high register and a breathier phonation in the low register at vowel onsets. Another interesting pattern that was not clear in the H1*-H2* results is that low-register tone B2 has a lower CPP than its high-register counterpart B1. This disparity indicates that B2 has a final creaky phonation, while B1 does not show final glottalization (like the two A tones).

Other indicators of phonation type, such as H1*-A1* and H1*-A3*, are not reported here as they yield similar results. They are provided in Appendix 5-5.

Vowel quality

Figure 5-12 represents the mean F1 for the five vowels /iː, ɛː, uː, ɔː, aː/ in Rục as conditioned by the six tones, which are further grouped by *tone category* (diachronic codas) and *register*. The general tendency is for F1 to be lower, indicating vowel raising in the low register. This difference is more robust in open and open-mid vowels /ɛː, ɔː, aː/ than in the two closed vowels /iː, uː/.

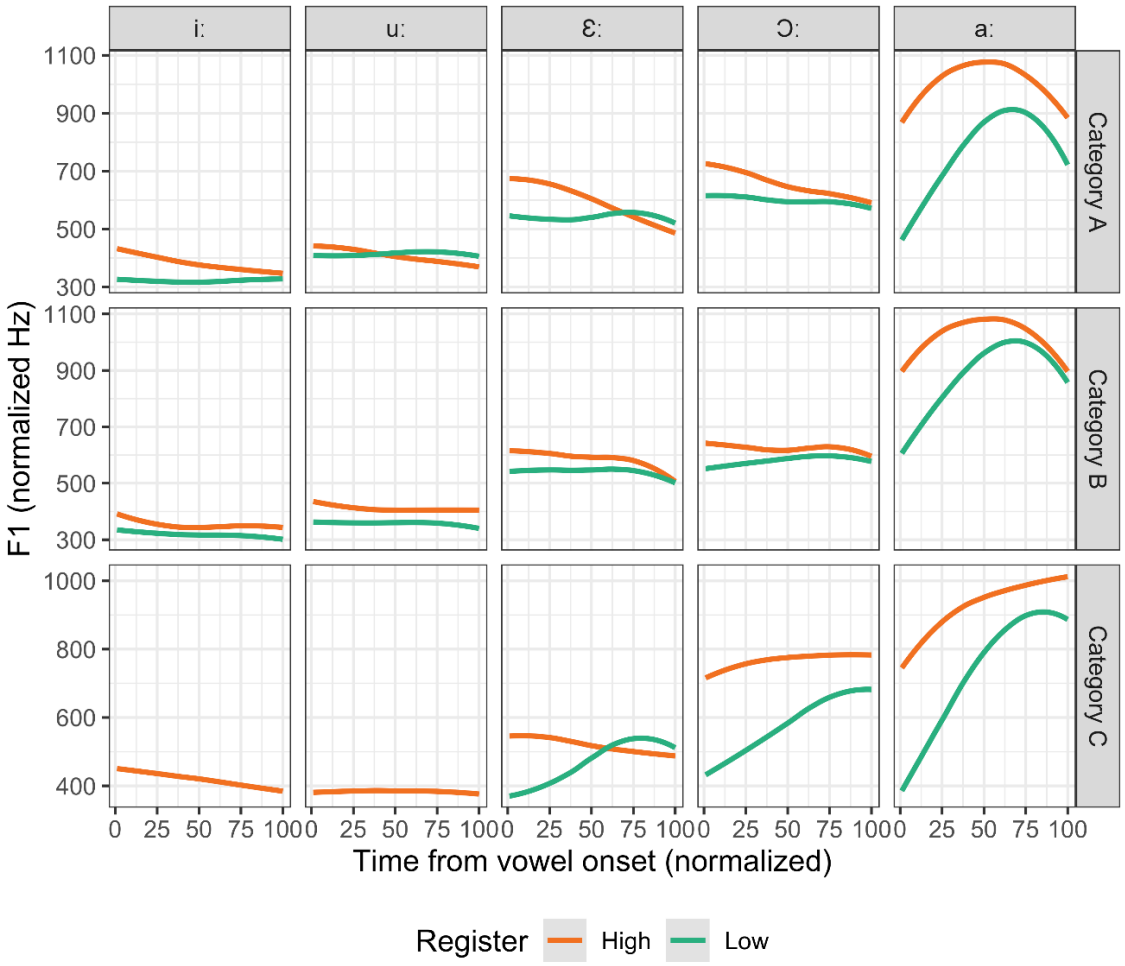


Figure 5-12. Mean F1 of vowels in Rục by *tone category* and *register*.

Figure 5-13 represents the mean F2 of the five vowels, also subgrouped by *tone category* and *register*. Of the five vowels, the open vowel /aː/ (rightmost panel in Figure 5-13) exhibits the most consistent F2 difference between the high and low registers, by which F2 is higher in the low register. Along with a lower F1, this indicates vowel raising and fronting in the low register. The F2 of the closed vowel /iː/ is higher in the high register tone B1. Along with a lower F1 in the same context, this indicates that the close vowel /iː/ is realized as a rising diphthong /^{e}iː/ in the high register. The higher F2 in the low-register /uː/suggests vowel fronting.

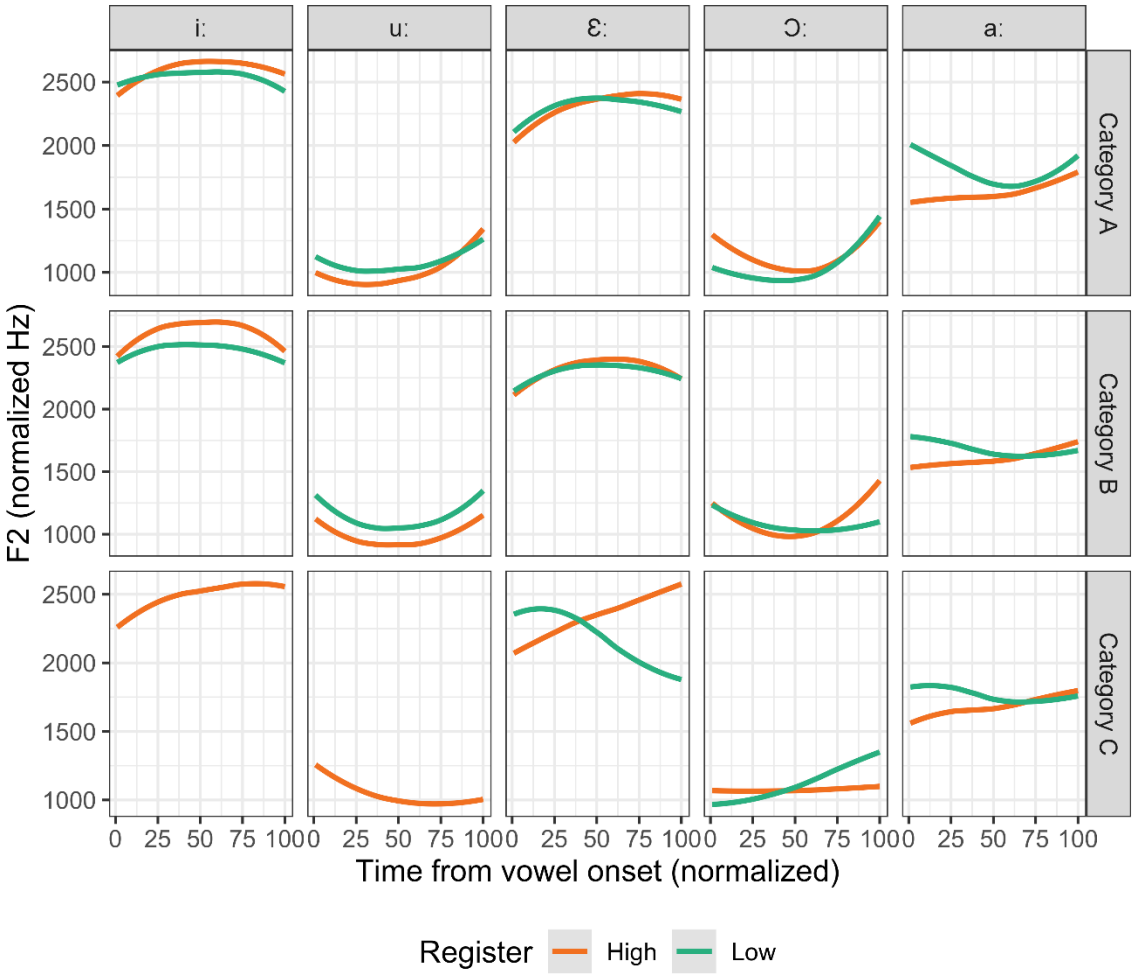


Figure 5-13. Mean F2 of vowels in Rục by *tone category* and *register*.

Figure 5-14 presents the GAMM-predicted F1 and F2 differences between high- and low-register vowels by tone category.

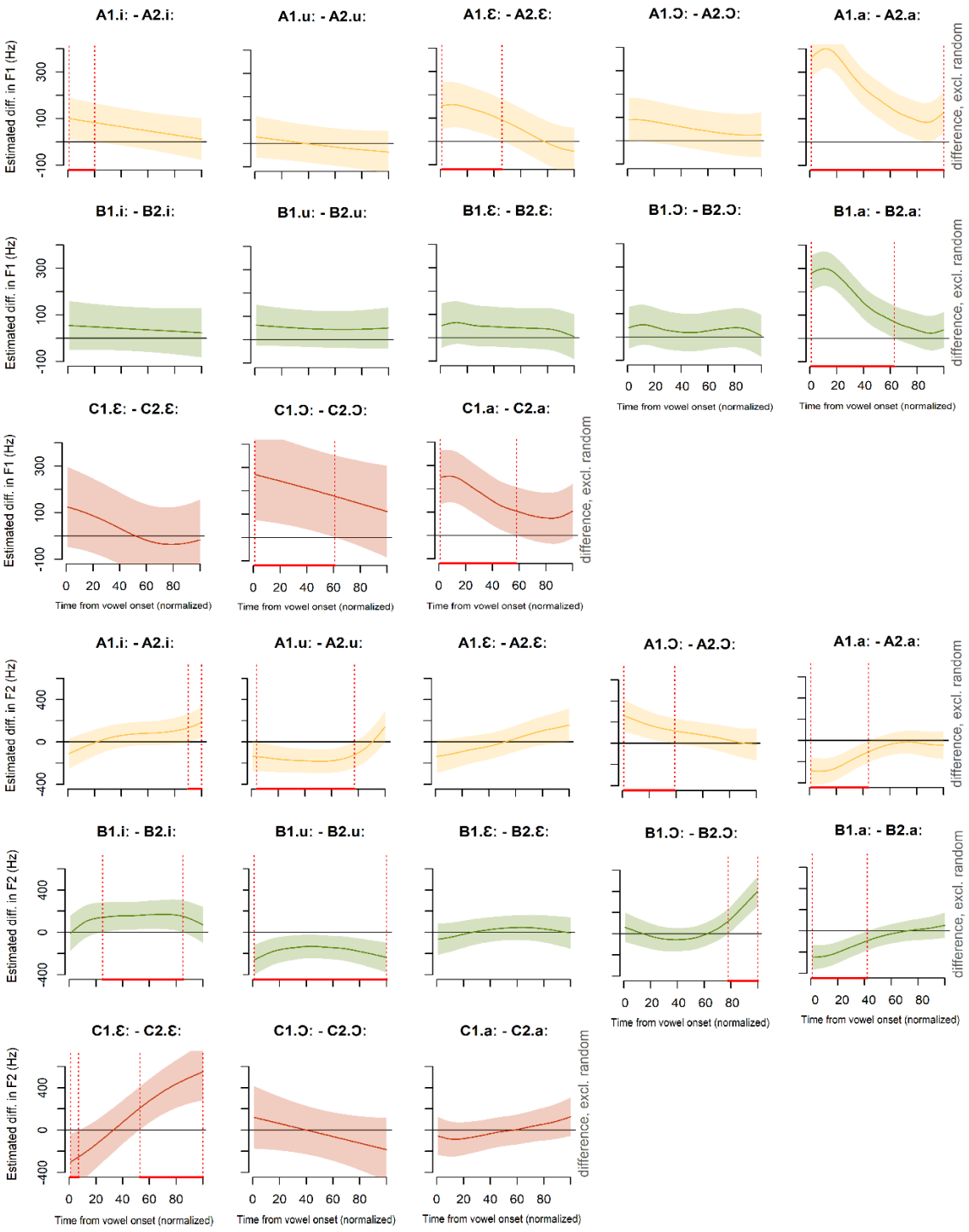


Figure 5-14. GAMM-predicted F1 (three upper rows) and F2 (three lower rows) difference between high- and low-register vowels in Rục by *tone category* and *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons do not touch the horizontal line at y = 0, the difference is significant. Vertical dotted red lines and a red bar on the x-axis further mark significant intervals.

Figure 5-15 gives a more holistic view of the five vowels by Rục tones as it presents formant changes from vowel onset to vowel midpoint.

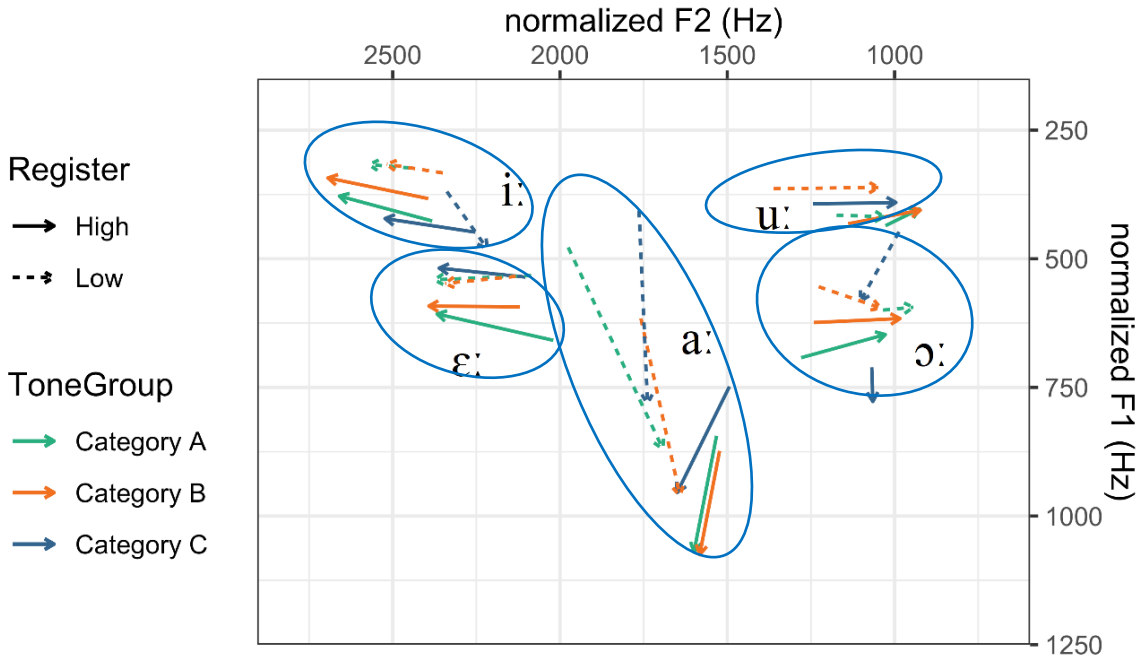


Figure 5-15. The five vowels in Rục, from their first to mid (arrows) points, by *tone*. The eclipses used to mark the relative spaces of the five vowels are added for visual convenience and do not correspond to statistical calculations.

In Figure 5-15, one can again note the rough division between the high register (solid lines) and the low register (dashed lines), by which vowels in the low register have a lower F1, indicating a more closed articulation. This is most apparent in the open vowel /aː/, where the vowel onset in the low register is raised to as high as the upper half of the vowel space: /aː/ in the low-register tones is realized as the falling diphthong [ᵊaː].

The two close vowels /iː, uː/ exhibit the least formant differences between the two registers. However, in some extreme cases, the close vowel /iː/ is realized as the rising diphthong /ᵉiː/ in the high-register tones. No parallel change from /uː/ to /ᵒuː/ was observed in the data set.

Vowel duration

To investigate vowel duration as a function of tone/register, only the 2021 recordings were used as they were better controlled for codas, including only open syllables with the tones A1, A2, B1, and B2, and the final glottal fricative /-h/ in syllables conventionally marked as having the two tones C1 and C2.

Figure 5-16 represents vowel duration in syllables with the six tones of Rục. The most apparent pattern one can note from the figure is that the vowel in syllables with C1 and C2 tones is much shorter than in syllables with A and B tones because the final fricative /-h/ makes up the second half of the rhyme duration. As mentioned above, this has been phonologized: there is no vowel length contrast in syllables bearing C tones. It also appears that A2 and C2 tones are longer than their high register A1 and C1. However, tones B1 and B2 do not seem to differ in duration. The longer vowel duration in C2 than in C1 could be partly explained by the observation that -h is more likely to be voiced in the low register than in the high register, making the transition between the vowel and the coda less abrupt and therefore lengthening the voicing interval.

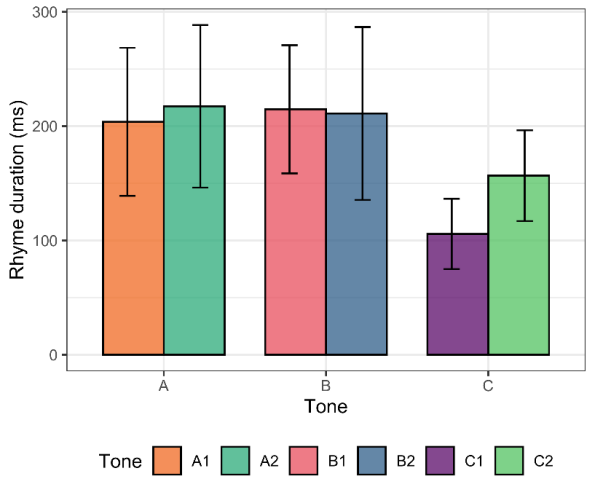


Figure 5-16. Vowel duration by *tone*. Tones from the same group are juxtaposed.

The optimal model fitted to the vowel duration data only includes the effect of *register* (Table 5-16). It confirms that the low register has a longer duration than the high register, the effect being due to the longer duration of A2 than A1 and C2 than C1.

Table 5-16. Results summary of the linear mixed-effects model fitted to the vowel duration data. Model: *duration ~ register + (1|Subject) + (1|Word).*

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	175.48	10.23	83.04	17.16	0.00
RegisterLow	27.70	12.29	53.86	2.25	0.03**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

5.2.2.3 Semi-articulatory property: EGG

The mean open quotient (OQ) associated with the six tones of Rục is given in Figure 5-17. The figure includes OQ results obtained from both methods: dEGG (left panel) and Howard (right panel).

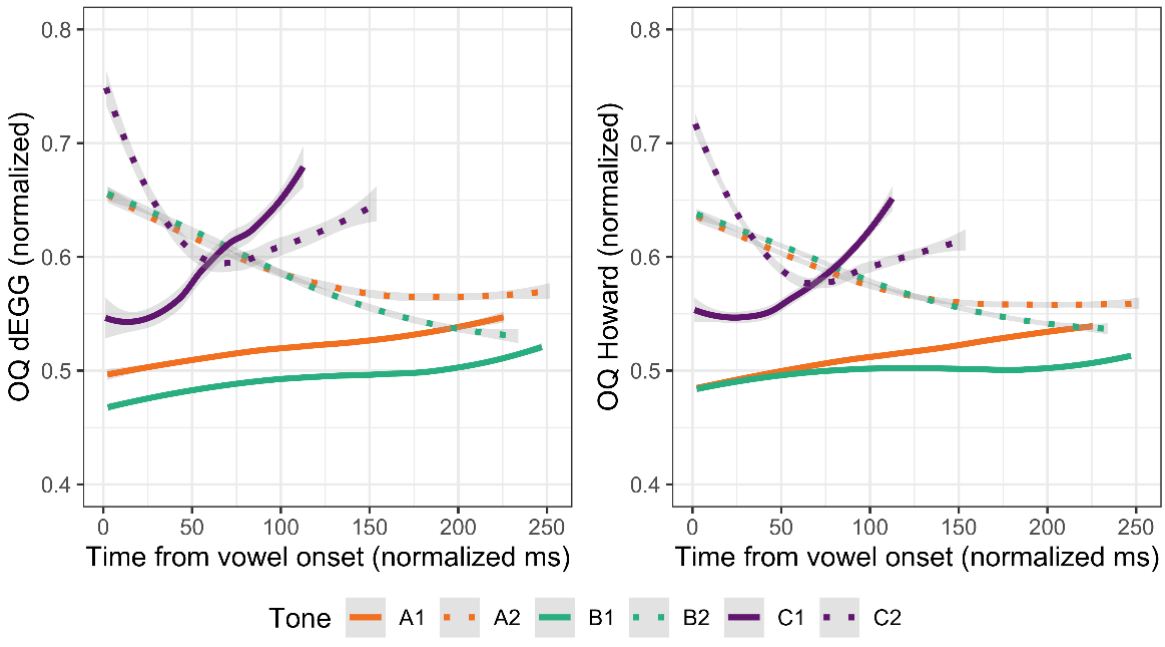


Figure 5-17. Mean OQ (open quotient) of the six Rục tones, calculated by two methods, dEGG (left) and Howard (right).

As can be seen in Figure 5-17, the low-register tones have a higher OQ than their high-register counterparts. This result further confirms the breathier phonation of the low as compared with the high register observed in the acoustic results above. The dEGG OQ results have a slightly broader range of values than the Howard OQ results; see, for instance, the higher onset of C2 and the lower onset of tone B1 or the rising offset of C1 and C2 (ending in the laryngeal fricative /h/), that reach higher OQ values with dEGG than with Howard. The dEGG results also show a slight difference between B1 and B2 in their first half, contrary to the Howard results. As explained in Chapter 4, differences between the dEGG and Howard results are attributable to differential tracking of double peaks (and troughs) in the EGG signal.

5.2.2.4 Group and individual variation

Sex and *age* do not seem to affect the f0 and H1*-H2* of Rục tones consistently, as can be seen in the empirical (upper panel) and GAMM-predicted (lower panel) values in Figure 5-18 and Figure 5-19, respectively. The height and contour of f0 and H1*-H2* of each tone show no significant deviation between the four groups of speakers.

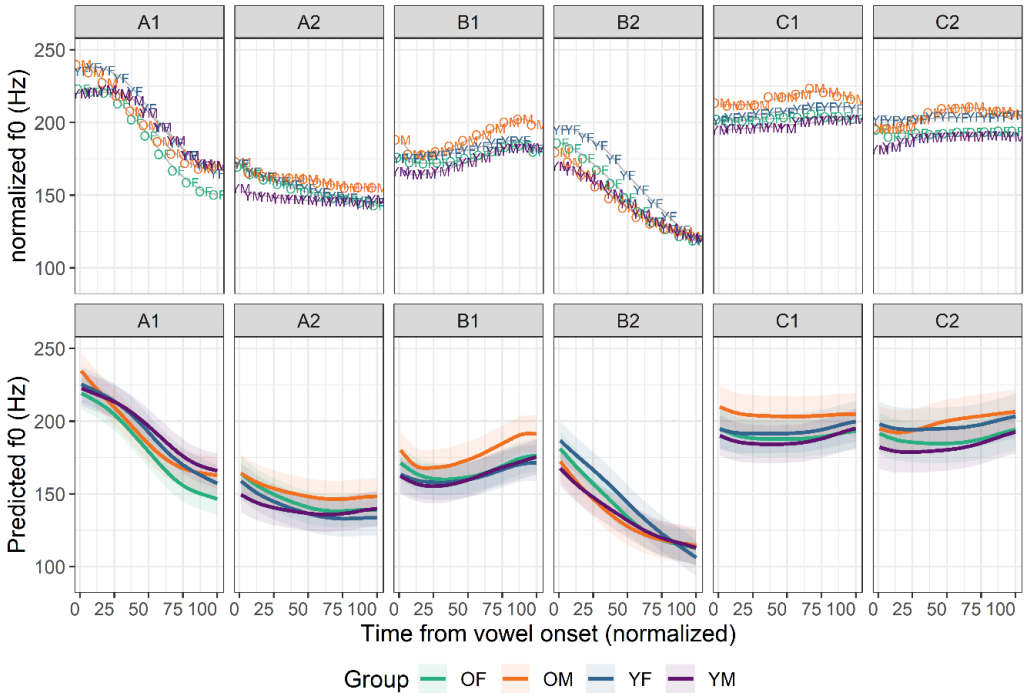


Figure 5-18. Empirical (*upper*) and GAMM-predicted (*lower*) f0 in the production of the six Rục tones across target *words, repetitions,* and *vowel,* by *social group*. Ribbons in the prediction panels represent 95% CIs.

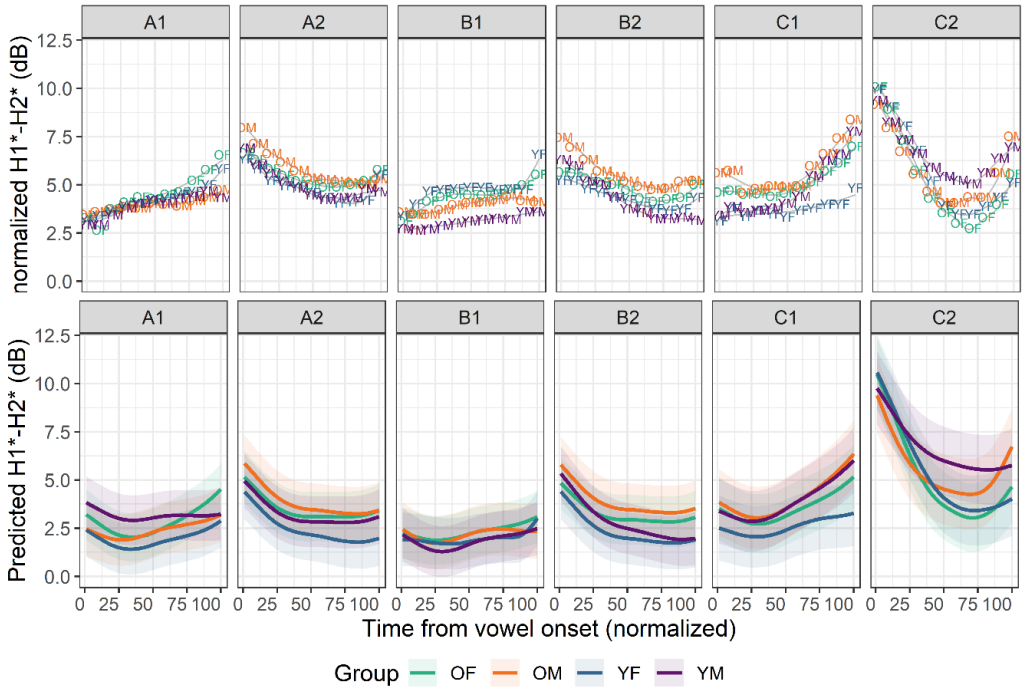


Figure 5-19. Empirical (upper) and GAMM-predicted (lower) H1*-H2* in the production of the six Rục tones across target *words, repetitions,* and *vowel,* by *social group*. Ribbons in the prediction panels represent 95% CIs.

Let us now turn to the individual variation in the speakers' realization of the phonetic characteristics of Rục tones. The production weight, or the magnitude of the differences in VOT, f0, phonation type (H1*-H2*), vowel quality (F1, F2), and vowel duration between the two registers, were assessed via Cohen's *d* scores (Cohen, 1988), a measure of effect size, following the method used in Brunelle et al. (2020) and Tạ et al. (2022). For each of the phonetic properties, Cohen's *d* scores were calculated as vowel-weighted and tonal-pair-weighted mean differences between the high and low registers divided by the tone-weighted standard deviation at the first sampling point. The first normalized sampling point was chosen to calculate Cohen's *d*'s because, as shown in Section 5.2.2.2, the maximum difference between the high-register and low-register tones in the same tone category is usually at vowel onset. Two exceptions were made. Firstly, the sampling point for calculating Cohen's *d* for f0 in category B, the mid-rising B1 and mid-falling B2, was the last normalized sampling point, where the difference is roughly the highest. Secondly, C1 and C2 were not included in calculating the grand Cohen's *d* for f0, as there was no significant f0 difference between these two tones (Section 5.2.2.2). The formula to calculate Cohen's *d* scores is as follows:

$$\textit{Cohen's } d_{\text{(VOT| f0|H1*-H2*|F1|F2|vowel duration)}} = \left(\frac{(A1-A2)+(B1-B2)+(C1-C2)}{3}\right) / \sqrt{\frac{SD_{A1}^2+SD_{A2}^2+SD_{B1}^2+SD_{B2}^2+SD_{C1}^2+SD_{C2}^2}{6}}$$

where SD is the standard deviation. The above formula was used to calculate Cohen's *d* for each of the five vowels, and the final Cohen's *d* for each property was averaged from these vowel-specific values. For each property, a higher value in the high than the low register results in a positive Cohen's *d* score and vice versa. For example, based on the results in Section 5.2.2.2, we expect positive Cohen's *d* scores for f0 and negative Cohen's

d scores for H1*-H2*. As a rule of thumb, Cohen's *d* scores above 0.8 and below -0.8 indicate a large effect size (Cohen, 1988).

Cohen's *d* scores for the six phonetic properties used to distinguish Rục registers, subgrouped by *speaker* and *year*, are given in Figure 5-20.

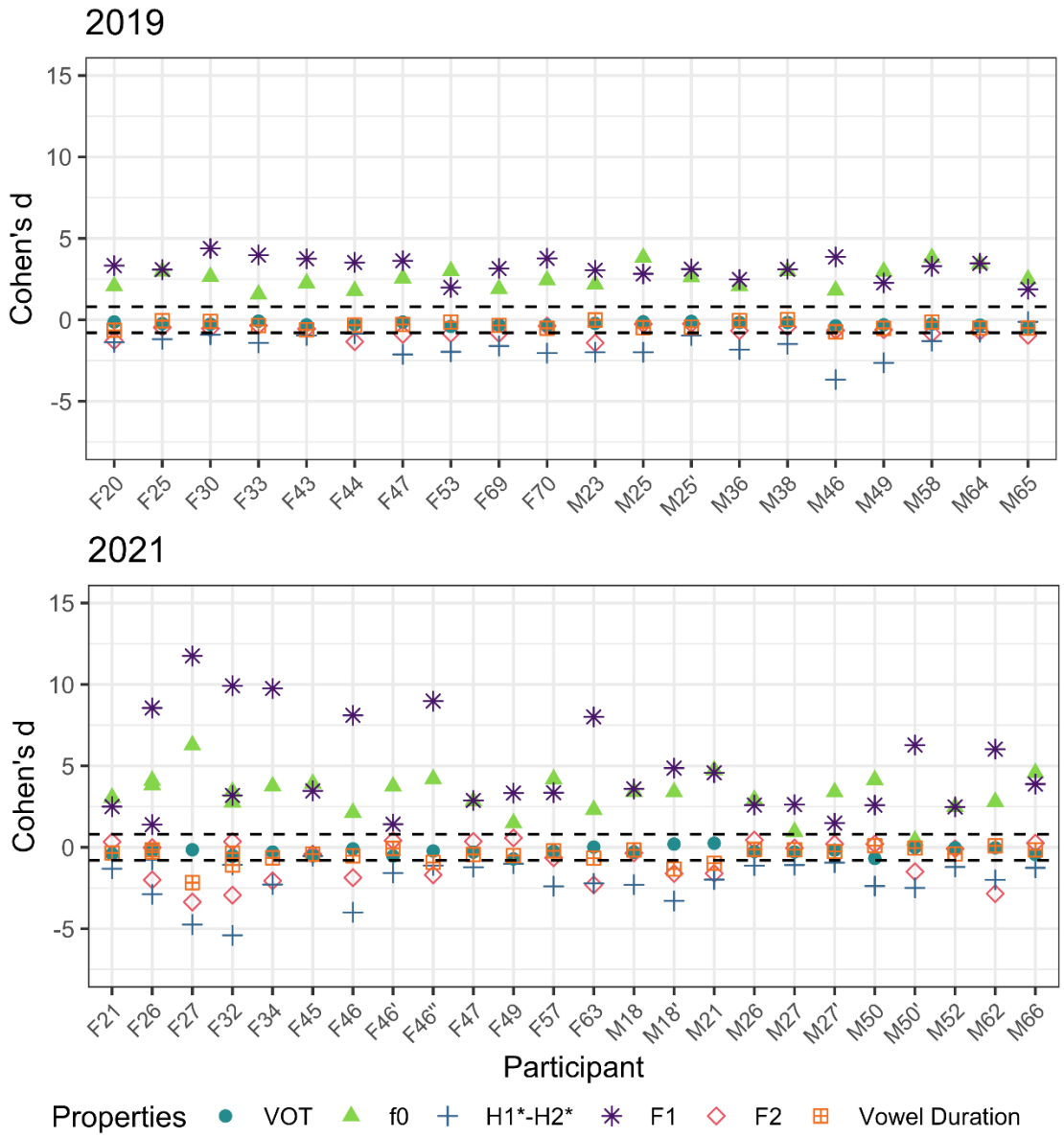


Figure 5-20. Individual variation in the use of phonetic properties to differentiate high- and low-register tones by *speaker* and *year*. Participants' numbers indicate sex (M/F), followed by age at the recording time; the apostrophes differentiate same-age participants.

We can first see in Figure 5-20 that there are differences in the distribution of Cohen's *d*'s between 2019 and 2021. Cue weights seem larger for F1, F2 and H1*-H2* in 2021. For example, there were more F1 values larger than 7.5 and more F2 and H1*-H2* values around or smaller than -5 in 2021, indicating greater vowel quality and phonation type distances between the two registers compared to those of 2019. These differences between years are likely an artifact of the experimental protocol: in 2021, recordings were conducted after participants took part in a perception experiment on the register (reported below). This led them to be more aware of the purpose of the recordings than in 2019 and to overenunciate the register contrast.

Yet, we can see in Figure 5-19 that in both years, F1 has the highest absolute Cohen's *d*s for most speakers, indicating that this is the most prominent production cue differentiating the high- and low-register tones. F0 is also consistently higher in high- than low-register tones, which is expected given the higher onset of A1 than A2 and the higher offset of B1 than B2. H1*-H2* has a strong production weight, which is higher than that of f0, especially in the 2021 results. F2 is not as robust as F1, as evidenced by its lower scores. VOT and vowel duration both have weak production weights, but vowel duration is the weakest cue. These generalizations seem to apply across sex and age, which suggests that register plays no indexical role and is not undergoing change.

5.2.3 Summary of the production results

The results of this first experimental study of the Rục tonal system, on the one hand, confirm the previously described presence of at least four tones in open syllables, which vary in a bundle of phonetic cues, including f0 height, f0 contour, phonation type, vowel

quality, final glottalization, and VOT. On the other hand, this study also reveals that the two tones C1 and C2 (in h-ending syllables) are phonetically radically different from tones A1 and A2, of which they are traditionally considered allotones. The phonetic characteristics of these Rục tones can be summarized as follows (Table 5-17):

- **Tone A1** is a high-falling tone with a modal phonation at its beginning, an unmodified vowel quality, and no final glottalization.
- **Tone A2** is a low-falling tone with a breathy phonation at its beginning, a higher or falling-diphthongized vowel, and no final glottalization.
- **Tone B1** is a mid-rising tone with a modal phonation at its beginning, an unmodified vowel, and a weak degree of final glottalization.
- **Tone B2** is a mid-rising tone with a breathy phonation at its beginning, a higher or falling-diphthongized vowel, and a certain degree of final glottalization, which is stronger than what is found in **B1**.
- **Tone C1** is a high-level tone with a modal phonation at its beginning, an unmodified vowel, a short vowel duration, and no final glottalization.
- **Tone C2** is a high-level tone with a breathy phonation at its beginning, a higher or falling-diphthongized vowel, short vowel duration, and no final glottalization.

This study did not include enough checked syllables (ending in stops) to describe the two tones D1 and D2 comprehensively. However, from the inspection of the phonetic realization of some stop-ending syllables in the wordlists, their characteristics could be roughly sketched as follows:

- **Tone D1** is a mid-rising tone with a modal phonation at its beginning, an unmodified vowel quality, and no final glottalization.
- **Tone D2** is a mid-falling tone with a breathy phonation at its beginning, a falling-diphthongized vowel, and no final glottalization.

Table 5-17. Phonetic characteristics of Rục tones. The descriptions of tones D1 and D2 (italicized) are speculative and based on a limited number of recorded tokens.

Tone / ***Properties***	**A1**	**A2**	**B1**	**B2**	**C1**	**C2**	***D1***	***D2***
Original onsets	*voiceless	*voiced	*voiceless	*voiced	*voiceless	*voiced	**voiceless*	**voiced*
Original finals	*-sonorous	*-sonorous	*-ʔ / ˀ	*-ʔ / ˀ	-h	-h	*-p/t/c/k*	*-p/t/c/k*
f0 height and contour	High-Falling	Low-Falling	High-Rising	Low-Falling	High-Level	High-Level	*High-Rising*	*High-Falling*
Final glottalization	No	No	Yes	Yes	No	No	*No*	*No*
Phonation type at vowel beginning	Normal	Breathy	Normal	Breathy	Normal	Breathy	*Normal*	*Breathy*
Vowel quality	Normal	Higher or falling diphthongized	Normal	Higher or falling diphthongized	Normal	Higher or falling diphthongized	*Normal*	*Higher or falling diphthongized*
Length	Medium	Long	Medium	Long	Short	Short	*Short*	*Short*
VOT	Shorter	Longer	Shorter	Longer	Shorter	Longer	*Shorter*	*Longer*

This study thus establishes a systematic differentiation between the high-register tones, A1, B1, C1, and D1, and the low-register tones, A2, B2, C2, and D2, by which, compared to the former group, the latter group has a lower f0, a breathier phonation type, falling diphthongized (or raised) vowels, a longer duration (although the effect is tonal-pair-specific), and a longer VOT. Semi-articulatory results show higher values for OQ (open quotient) in the low-register tones A2, B2, and C2 than in the high-register tones A1, B1, and C1 (Section 5.2.2.3) as expected, further confirming the breathier phonation in the low than in the high register.

All of these distinctive features were already mentioned in previous studies on Rục tone (Nguyễn et al., 1988; Nguyễn, 1993; Solntsev et al., 2001b), but the systemic nature of the contrast between the two registers was not reported. This differentiation between two tonal groups in Rục is precisely the same as that between the high and low registers in register languages of the Austroasiatic phylum (Henderson, 1952; Huffman, 1976; Ferlus, 1997b; Brunelle & Kirby, 2016; Brunelle & Tạ, 2021). In other words, register features are still present in Rục along with phonetic features derived from the loss of the final glottal stop -ʔ. Therefore, we can consider the tonation system Rục has *a hybrid system combining tone and register* properties instead of a purely tonal system.

Rục speakers are relatively consistent in using phonetic cues to realize the tones, although some individual variation was observed (Section 5.2.2.4). They employ F1 and f0 (height and contour) as the two most salient tonation cues. Phonation type is also a strong cue to differentiate the two groups. Vowel duration and VOT are less reliable production cues for register as they have smaller (or even null) Cohen's *d*s, and even Cohen's *d*s going in the opposite direction in some speakers (Figure 5-20).

The seven speakers who recorded different wordlists in 2019 and 2021 had comparable Cohen's *d*s for the phonetic correlates of the tone and register, meaning that their phonetic realizations did not change over this period of time. The only exception is that one young woman (born in 1994) showed noticeable increases in Cohen's *d*s for phonation type (exemplified by H1*-H2*) and vowel quality (F1, F2) in 2021 compared to 2019. Whether this is only accidental or a suggestive sign of an actual change in her production cue weights over time is impossible to determine. Systematic studies assessing the extent of change in cue weights over the life of individuals are needed.

The comparisons of f0 and H1*-H2* across four social groups (younger men, older men, younger women, and older women) in Section 5.2.2.4 suggest that the phonetic realization of Rục tones is comparatively uniform in the language community. In other words, the complex/hybrid system of tone and register in Rục is stable, at least from the production perspective.

This study did not evaluate the influence of bingualism because I could not find monolingual speakers in the community to constitute the control group. We can assume that the degree of bilingualism and the time of L2 (Vietnamese) learning differ between the young and the old because Rục children speak Vietnamese from a young age when attending school where Vietnamese is the instructional language. If this is the case, bilingualism does not appear to have an apparent effect on the realization of Rục tonation between speaker groups. The topic of tonation changes induced by language contact is open for future studies.

5.3 The perception experiment

5.3.1 The need for a perception study

The results of the production study showed that the tonation contrast in Rục is signalled by multiple phonetic cues, including f0 height, f0 contour, F1, phonation, final glottalization, and VOT. These properties are generally ordered similarly across speakers (cue weighting). Most speakers first distinguish tones in the two registers in terms of F1, followed by f0 and phonation type. These multiple tonation cues offer an opportunity to investigate how relevant they are in the listeners' perception. In other words, a perception study could reveal the perceptual weights of the phonetic properties of the Rục tonation contrast and therefore contribute to the study of the theoretically and practically important link between production and perception in general and of sound change specifically (Schertz & Clare, 2020).

Change could be led by perception if listeners start shifting their attention to a weaker production cue (Ohala, 1981; Ohala, 1989; Beddor, 2009; Ohala, 2012; Pinget, 2015). Some Rục listeners, for example, could start weighting f0 over F1 even if it is a weaker production cue. Such a cue shifting would be made possible by the abundance (and redundancy) of the tonation cues in Rục, allowing the listeners more flexibility in their perception of the contrast. Then these listeners might start increasing the production weight of this newly emphasized cue to match their perception. This would lead to a cue restructuring of the tonation contrast led by perception. This type of perception-led sound change has been observed in southern British /u/-fronting (Harrington, Kleber, & Reubold, 2008; Harrington, 2012; Kleber, Harrington, & Reubold, 2012), Dutch obstruent devoicing

(Pinget, 2015; Pinget, Kager, & Van de Velde, 2016, 2020), Korean tonogenesis in Hunchun and Dangdong dialects (Schertz, Kang, & Han, 2019), and Southern Yi restructuring of register into vowel contrast (Kuang & Cui, 2018).

On the opposite, shifts in the weight of perception cues could well be triggered by changes initiated in production. For example, we can observe in Figure 5-19 that some speakers have roughly the same Cohen's *d* score for both F1 and f0; some others even have a higher score for f0 than F1. Such increases of the production weight of a secondary phonetic cue while the primary cue is still present is illustrated by the phonologization of VOT-associated f0 in Malagasy (Howe, 2017), Afrikaans (Coetzee et al., 2018), and Seoul Korean (Silva, 2006; Kang & Han, 2013; Kang, 2014; Bang et al., 2018).

Therefore, in my second field trip to the Rục community, I carried out a perception study of the tonation contrast to (i) assess the perceptual weights of the tonation properties and (ii) to see if there is any mismatch between production and perception that could inform us on any sound change in progress in the Rục tonation system.

5.3.2 Method

5.3.2.1 Participants

Thirty-nine listeners participated in this perception study. However, six younger men, two younger women, and one older woman could not finish the task[21] (Table 5-12). Using 45 years old as the threshold between younger and older participants, similar to the production study, the remaining thirty listeners belong to four groups of eight younger men (*mean* =

[21] Note that for most of the participants, this is their first time seeing and using laptops and headphones. Despite my thorough instructions, many felt uncomfortable interacting with the device.

21.9, *sd* = 3.9), seven older men (*mean* = 57.5, *sd* = 5.6), eight younger women (*mean* = 26.5, *sd* = 4.3), and seven older women (*mean* = 48.1, *sd* = 4.5).

After finishing the perception task, thirteen participants agreed to record two minimal pairs identical to the stimuli to investigate the relationship between production and perception. Besides, the same data in 2019 from four men (three younger and one older men) and one older woman who also took part in this 2021 perception task were included in the investigation. All participants reported no hearing or speaking difficulty. They were compensated for their contribution to the studies.

5.3.2.2 Stimuli

Two sets of stimuli were Klatt-synthesized (Klatt, 1980; Weenink, 2009) separately to mimic two tonal pairs of A1 vs A2 and C1 vs. C2 with the vowel /a:/ and the onset /t/. The first pair is /ta:^{A1}/ '*grandfather'* vs. /ta:^{A2}/ '*right now.'* The second pair is /tah^{C1}/ '*unsalted'* vs. /tah^{C2}/ '*recover.'* To maximize naturalness, the stimuli were synthesized with a male voice and fine-tuned to mirror the production results of a typical male speaker born in 1955 who had been recorded in 2019.

The duration of the synthesized vowel in the A-tone pair is 300 ms, and that in the C-tone pair is 175 ms, reflecting the shorter duration of the vowel in the h-ending syllables (Section 5.2.2). A 170 ms segment of final fricative [-h] was extracted from an actual word produced by a male speaker and pasted into the second pair.

Four parameters were manipulated: VOT, f0, vowel quality, and phonation type. Three steps were synthesized for each parameter (5 steps for f0 in the A pair), as shown in Figure 5-20.

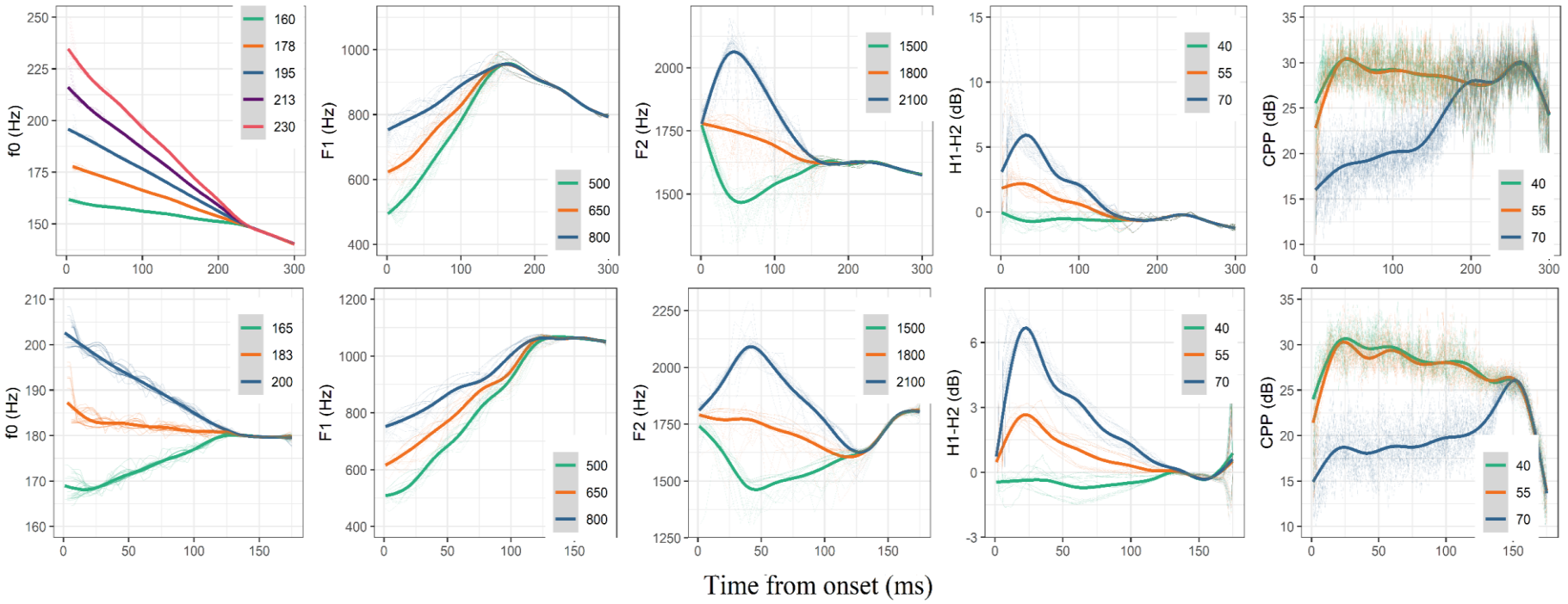


Figure 5-21. Mean values of the acoustic parameters of the stimuli in the perception experiment. Top panel: syllable /ta:/. Bottom panel: syllable /tah/. Thin lines represent individual trajectories of the tokens for each Klatt-synthesized syllable.

For each tone pair, the upper and lower values of these parameters were respectively set to the grand normalized means in the production of the high tone, A1 or C1, and the low tone, A2 or C2, from the production results in 2019 (Section 5.2.2). Except for VOT, equidistant f0, F1 (and F2), and phonation curves (more below) were generated. These values were set at vowel onset and were made to converge to reach a common target at 150 ms for the A-tone stimuli and 125 ms for the C-tone stimuli. They then remained identical until the end of the two synthesized 300 ms and 175 ms vowels, respectively.

The details of the Klatt parameters in synthesizing the two stimuli sets are as follows:

- **VOT**: Two VOT targets of 10 and 20 ms were synthesized for the A-tone pair. These values approximately reach the averaged mean VOT of the two tones, A1 and A2, with coronal onsets (Table 5-13). Three VOT targets of 10, 20, and 30 ms for the C-tone pair were synthesized. This last 30 ms was an exaggerated VOT to test the effect of longer VOTs on listeners' perception of the tone/register distinction. Despite this additional VOT step, the two minimal pairs had a comparable number of stimuli because, as explained below, the C-tone pair had fewer f0 targets than the other pair.

- **f0**: The five f0 targets at vowel onset for the A-tone stimuli were 160, 178, 195, 213, and 230 Hz. The three f0 targets at vowel onset for the C-tone stimuli were 165, 183, and 200 Hz. A fixed f0 target at 150 Hz was set at 150 ms into the vowel for the A-tone stimuli. Then f0 gradually falls to 140 Hz at vowel offset to reflect the natural falling trajectory of the two tones. For the C-tone stimuli, the f0 target at the converging point of 125 ms was 180 Hz, and this f0 was kept constant until

the vowel offset, reflecting the naturally high-level trajectories of the two C tones. Different numbers of f0 steps for the two stimuli sets mirror the large f0 difference between A1 and A2 tones and the much narrower (and not significant) f0 difference between C1 and C2 tones (Section 5.2.2.2). The chosen f0 values also made the distance between f0 steps in both minimal pairs relatively uniform (17 ~ 18 Hz).

– **F1** and **F2**: The three F1 targets at vowel onset for both pairs of stimuli sets were 500, 650, and 800 Hz. The three covarying F2 targets were 1500, 1800, and 2100 Hz. For the A-tone stimuli, F1 was set at 1000 and 800 Hz at the convergence point and the vowel offset, respectively. F2 for targets for these two points were 1650 and 1600, respectively. For the C-tone stimuli, the corresponding values were 1100 and 1050 Hz and 1650 and 1850 Hz, respectively. The F1 and F2 differences between two minimal pairs at their converging and offset points mirror the effect of the final fricative -h on the preceding vowel in the C pair.

  In production, F2 does not neatly covary with F1, but as F1 is a much more salient production cue than F2 is, and to keep the duration of the experiment reasonable, three F2 targets were set to covary with three F1 targets in both minimal pairs.

– **Phonation** (Voice Quality - VQ): Phonation was synthesized by manipulating two Klatt synthesis parameters, open quotient (OQ) affecting spectral slopes and breathiness amplitude (BA) adding noise to the stimuli and affecting CPP. The three phonation targets were set at vowel onset were modal voice (OQ = 0.4, BA = 0 dB), breathy voice (OQ = 0.7, BA = 66 dB), and intermediate voice quality (OQ = 0.55, BA = 33 dB). At the converging point of the two stimuli sets, phonation was set to

the modal voice setting and remained unchanged until the vowel offset.

These manipulations resulted in 90 stimuli for the A tones pair (2 VOT * 5 f0 * 3 F1-F2 * 3 VQ) and 81 stimuli for the C tones pair (3 VOT * 3 f0 * 3 F1-F2 * 3 VQ). The orthogonal combinations of the parameters created tokens combining conflicting values that do not exist in actual production, such as a stimulus with a high f0 and a breathy voice quality. This is essential as I want to know which cue will bias the listeners' perception in which direction when listeners are exposed to conflicting cues. Four examples of the two stimuli sets are given in Appendix 5-6.

5.3.2.3 Procedure

The experiment was a two-alternative forced choice (2AFC) identification task designed and presented to the participants in OpenSesame (Mathôt, Schreij, & Theeuwes, 2012). The participants had to listen to the stimuli via headphones and identify the corresponding image on a laptop screen by pressing one of two keyboard buttons. I gave instructions to the participants in Vietnamese, as all of them are fluent in this language. An 18-year-old man also helped me explain to the participants what they were expected to perform in Rục.

Before identifying test tokens, the participants had to complete three training blocks for each minimal pair. The first training block included three repetitions for each of the two tokens most similar to the natural high register tone A1 (and C1) and low register tone A2 (and C2)[22]. The participants were guided to choose the accurate answer by visual

[22] The day before the experiment, I asked two Rục people to listen to some stimuli and tell me which four stimuli are the most typical pronunciation of the four target syllables. F1, f0, OQ, and VOT values of the four chosen typical tokens are as follows: /ta:^{A1}/ 800 Hz, 230 Hz, 0.4, and 10 ms; /ta:^{A2}/ 500 Hz, 160 Hz, 0.7, and 20 ms; /tah^{C1}/ 800 Hz, 200 Hz, 0.4, and 10 ms; and /tah^{C2}/ 500 Hz, 165 Hz, 0.7, and 30 ms. These four tokens have the maxima and minima of the four manipulated phonetic properties characteristic to either register.

instructions. In the second training block, five repetitions of each of the two tokens were presented, and the participants had to respond without visual instructions. In the last training block, nine tokens of the /taː/ set and six tokens of the /tah/ set were randomly selected. Between blocks, the listeners had a chance to take a short rest and ask clarification questions.

With the four typical tokens in the last two training blocks, the accuracy rates are all above chance: /taː^{A1}/ 79.8%, /taː^{A2}/ 78.1%, /tah^{C1}/ 61.4%, /tah^{C2}/ 65.6%. These rates all increased in the experimental blocks (82.8%, 86.9.8%, 67.6%, and 81.5%, respectively). The weaker results obtained for the low register tone C1 suggest that this synthesized syllable is more difficult to identify. I can think of two possible explanations for this. First, the shorter vowel duration in tokens with the two tones C1 and C2 increases the difficulty of identifying the tones. Secondly, the syllables /tah^{C1}/ and /tah^{C2}/are usually used in the collocations of /tah^{C1} ɓɔːj^{B1}/ and /tah^{C2} mat^{D1}/; therefore, presenting them in isolation could have made the task more difficult.

After completing the training blocks, the listeners carried out the experimental part of the task: three blocks of the /taː/ set alternated with three blocks of the /tah/ set, with each /taː/ block including 90 tokens and each /tah/ block including 81 tokens. It took 30 to 45 minutes per listener to go through the instructions and complete the task. Responses were not recorded if reaction times exceeded two seconds. A total of 7.9% (1209 tokens) of the 15390 potential responses given by the 30 participants were thus excluded.

Figure 5-22 illustrates the accuracy rates in identifying the four tokens by *social group* in the training blocks and the experimental block. Regarding tone C2 specifically, older men confused it with the high register tone C1 in the training blocks (accuracy rate

of 50%), but their accuracy in identifying this tone increased in the experimental block.

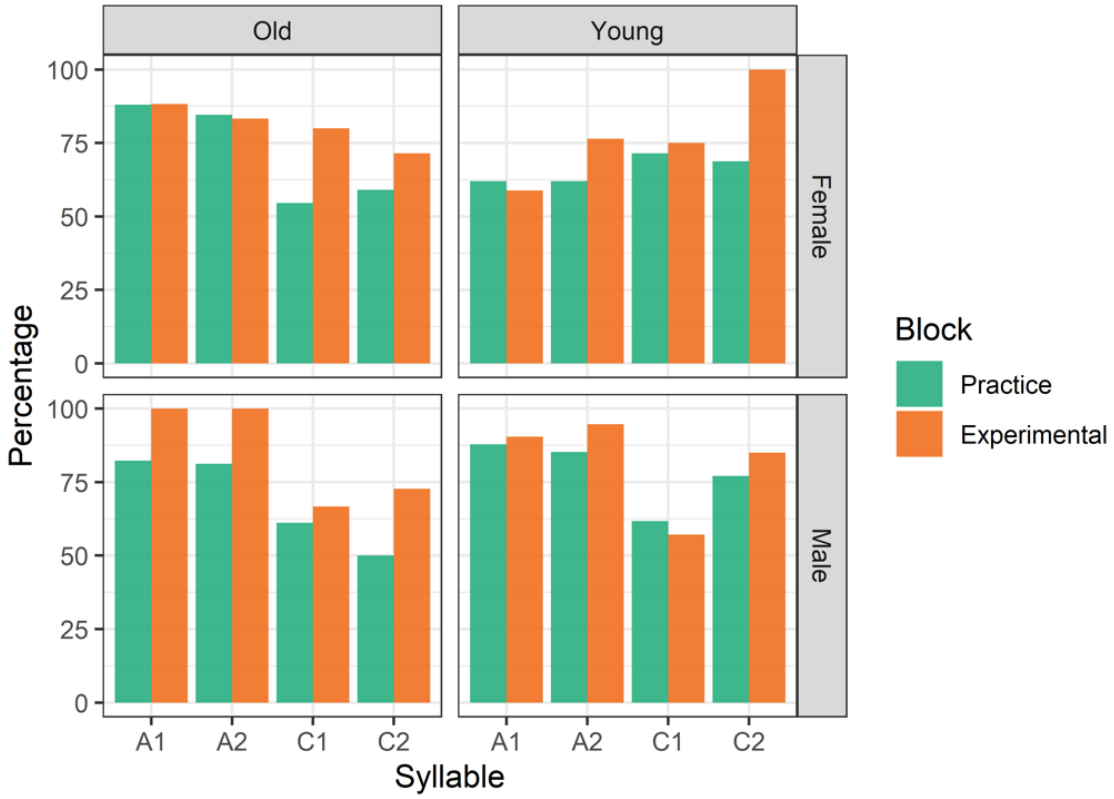


Figure 5-22. Accuracy rates of four representative tokens identification by *social group* in training blocks (left) and experimental blocks (right).

5.3.2.4 Data processing and statistical modelling

Logistic regressions were first fitted to the identification responses of individual listeners by minimal pair to determine if they did better than chance. The dependent variable was the probability of high tone choices (A1 and C1). The predicting factors were VOT, f0, F1, and VQ. These independent variables were dummy-coded. The by-syllable data from each listener was kept if the model results had at least one significant effect of the four independent variables. This step is meant to exclude data from listeners who did not fully understand the experiment requirements and responded randomly. The excluded data includes the dataset from eight listeners for /ta:/ stimuli and eleven listeners for /tah/

stimuli. Individual models will also be reported in Section 5.3.3 to show individual variation in the weighting of perceptual cues and the link between the production and perceptual cues of Rục tones.

Mixed-effects logistic regressions with the four main effects and all their two-way interactions were then fitted on the data obtained from all listeners (after data exclusion) to investigate their effects on the identification of tones in each minimal pair. These regressions include *subject* as a random intercept to account for individual variation.

5.3.3 Results

Figure 5-23 represents the proportion of A1 responses to A-type stimuli, organized along the four manipulated parameters. All acoustic parameters except VOT seem to affect listeners' choices. A higher F1 clearly favours A1 responses. A higher f0 also elicits A1 responses. Everything else being equal, a higher open quotient (and added breathiness) decreases the chance of A1 responses.

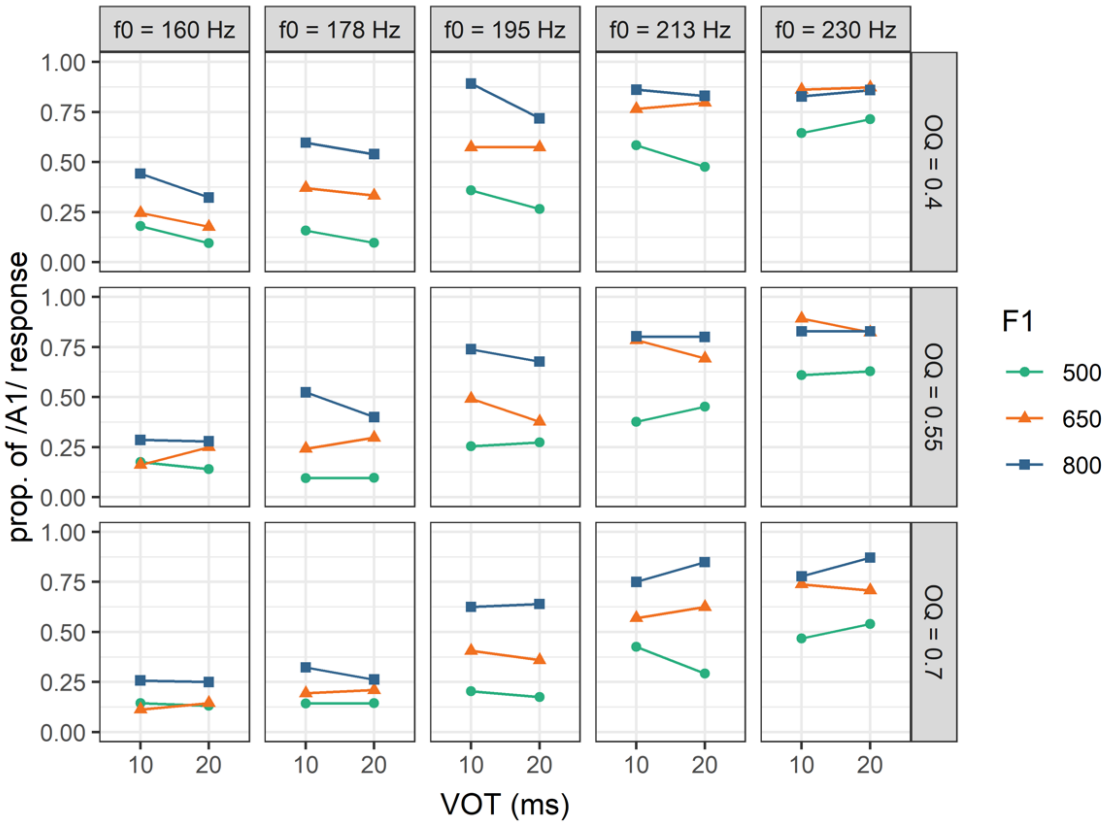


Figure 5-23. The proportion of the high-register tone A1 choices by the main factors of f0, F1, voice quality (open quotient), and VOT.

The proportion of C1 responses to C-type stimuli grouped along the four factors is given in Figure 5-24. Similar to the /ta:/ stimuli set, a higher F1 apparently elicits C1 choices, while f0 does not seem to play a role. It is hard to tell whether or not the open quotient affects the listeners' choices from visual inspection. VOTs of 20 and 30 ms seem to disfavours tone C1 responses.

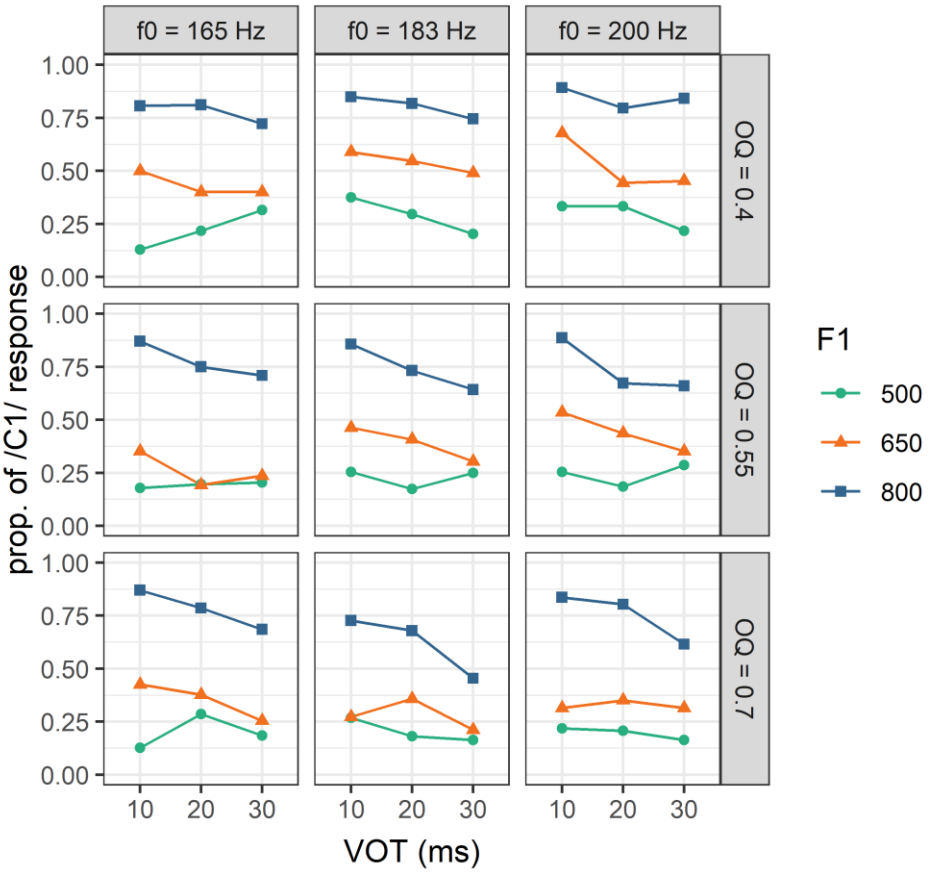


Figure 5-24. The proportion of the high-register tone C1 choices by the main factors of f0, F1, voice quality (open quotient), and VOT.

The model summaries for the /ta:/ and /tah/ stimuli sets are given in Table 5-18 and Table 5-19, respectively, and their estimated log odds are plotted in Figure 5-25 for visual convenience. The intercepts in both models are not significant, meaning the reference stimulus (with 10 ms VOT, all other parameters are at mid-range) is not distinct from 0 and is thus register-neutral. Moreover, the general proportion of responses to the /ta:/ set is 47.6% A1 vs. 52.4% A2, and to the /tah/ set, 46.4% C1 vs. 53.6% C2. These numbers suggest that the synthesizing resulted in a relatively balanced proportion between the high- and low-register stimuli.

Table 5-18. Table of estimates of the logistic regression model for /ta:/ stimuli. Estimates represent the log odds of the high-register tone responses. f0, F1, and VQ are centred.

	Estimate	*Std. Error*	*z value*	*Pr(>|z|)*
(Intercept)	-0.08	0.18	-0.45	0.65
F1	**1.21**	**0.22**	**5.40**	**0.00*** **
f0	**1.03**	**0.16**	**6.26**	**0.00*** **
VQ	**-0.57**	**0.10**	**-5.95**	**0.00*** **
VOT20	**-0.17**	**0.08**	**-2.11**	**0.03***
F1:f0	0.01	0.04	0.29	0.78
F1:VQ	-0.05	0.06	-0.88	0.38
F1:VOT20	0.01	0.09	0.16	0.87
f0:VQ	-0.02	0.03	-0.54	0.59
f0:VOT20	0.08	0.06	1.50	0.13
VQ:VOT20	0.16	0.09	1.90	0.06

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

These results confirm that, for the /ta:/ stimuli, increases in F1 and f0 both significantly favour the high-register tone A1 responses, with the former showing a larger effect. On the other hand, an increase in VQ clearly biases responses toward the low-register tone A2. A longer VOT of 20ms also expectedly favours listeners' choices toward the low-register tone, though its effect size is the smallest. None of the interactions between the main factors is significant.

For the /tah/ stimuli, F1 is the most prominently significant factor; it biases listeners' choices toward the high tone C1. Increases in f0 and voice quality significantly favour C1 and C2 responses, respectively. Similar to the /ta:/ stimuli, a VOT of 20 ms significantly biases responses toward the low-register tone C2. A VOT of 30 ms shows an even larger effect. However, we need to interpret this effect with care, as 30 ms is an exaggerated value intended to test the contribution of a long VOT in tone/register identification. When combined with an F1 increase, a 30 ms VOT significantly cancels the

former's effect and bias responses toward the low-register tone C2. When there is an increase in f0 in combination with an increase in voice quality, the favoured choice is the low-register tone C2.

Table 5-19. Table of estimates of the logistic regression model for /tah/ stimuli. Estimates represent the log odds of high-tone responses. f0, F1, and VQ are centred.

	Estimate	*Std. Error*	*z value*	*Pr(>|z|)*
(Intercept)	-0.07	0.24	-0.28	0.78
F1	**2.14**	**0.35**	**6.16**	**0.00*****
f0	**0.28**	**0.10**	**2.74**	**0.01****
VQ	**-0.54**	**0.14**	**-3.83**	**0.00*****
VOT20	**-0.36**	**0.14**	**-2.50**	**0.01***
VOT30	**-0.80**	**0.22**	**-3.59**	**0.00*****
F1:f0	-0.04	0.07	-0.57	0.57
F1:VQ	0.06	0.07	0.89	0.37
F1:VOT20	-0.22	0.13	-1.64	0.10
F1:VOT30	**-0.28**	**0.14**	**-2.01**	**0.04***
f0:VQ	**-0.18**	**0.06**	**-3.01**	**0.00****
f0:VOT20	-0.18	0.12	-1.52	0.13
f0:VOT30	-0.21	0.12	-1.78	0.07
VQ:VOT20	0.22	0.12	1.80	0.07
VQ:VOT30	-0.09	0.12	-0.75	0.45

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

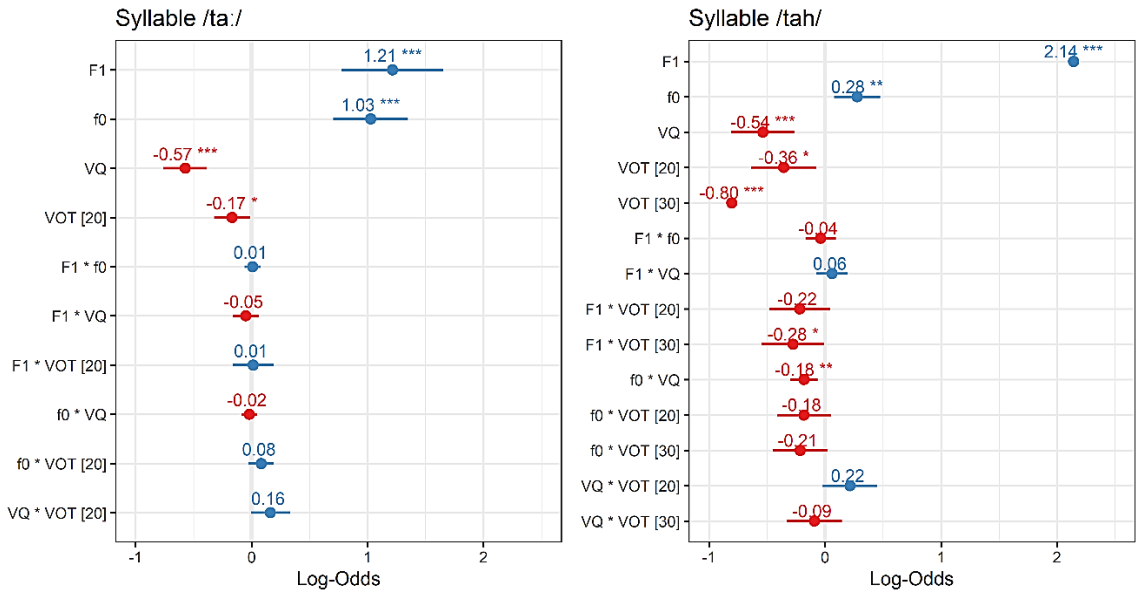


Figure 5-25. Estimated log odds of high-tone responses by fixed effect. Left panel: syllable /ta:/. Right panel: syllable /tah/. Positive log odds are in blue, and negative log odds are in red.

It is clear from Figure 5-25 that for both /ta:/ and /tah/ stimuli sets, F1, f0, and VQ are the dominant cues. For /tah/, F1 has the most salient effect on listeners' responses, seemingly the determining factor. However, f0 has a more limited role for /tah/ than /ta:/, reflecting its low production weight in the former (Section 5.2.2.2).

5.3.4 Individual and group variation and the production-perception link

5.3.4.1 Individual variation

Pooled results can hide individual variations in the weighting of perceptual cues. Therefore, logistic regression models with only the main effects of f0, F1, VOT and VQ were fitted to individuals' data sets. Estimated log odds of these factors, taken as proxies of their perceptual weights, are plotted in Figure 5-26 by *listener* and *syllable* (stimuli set), which

is similar to the representation of individual variation in Cohen's *d* scores for production cues in Section 5.2.2.4.

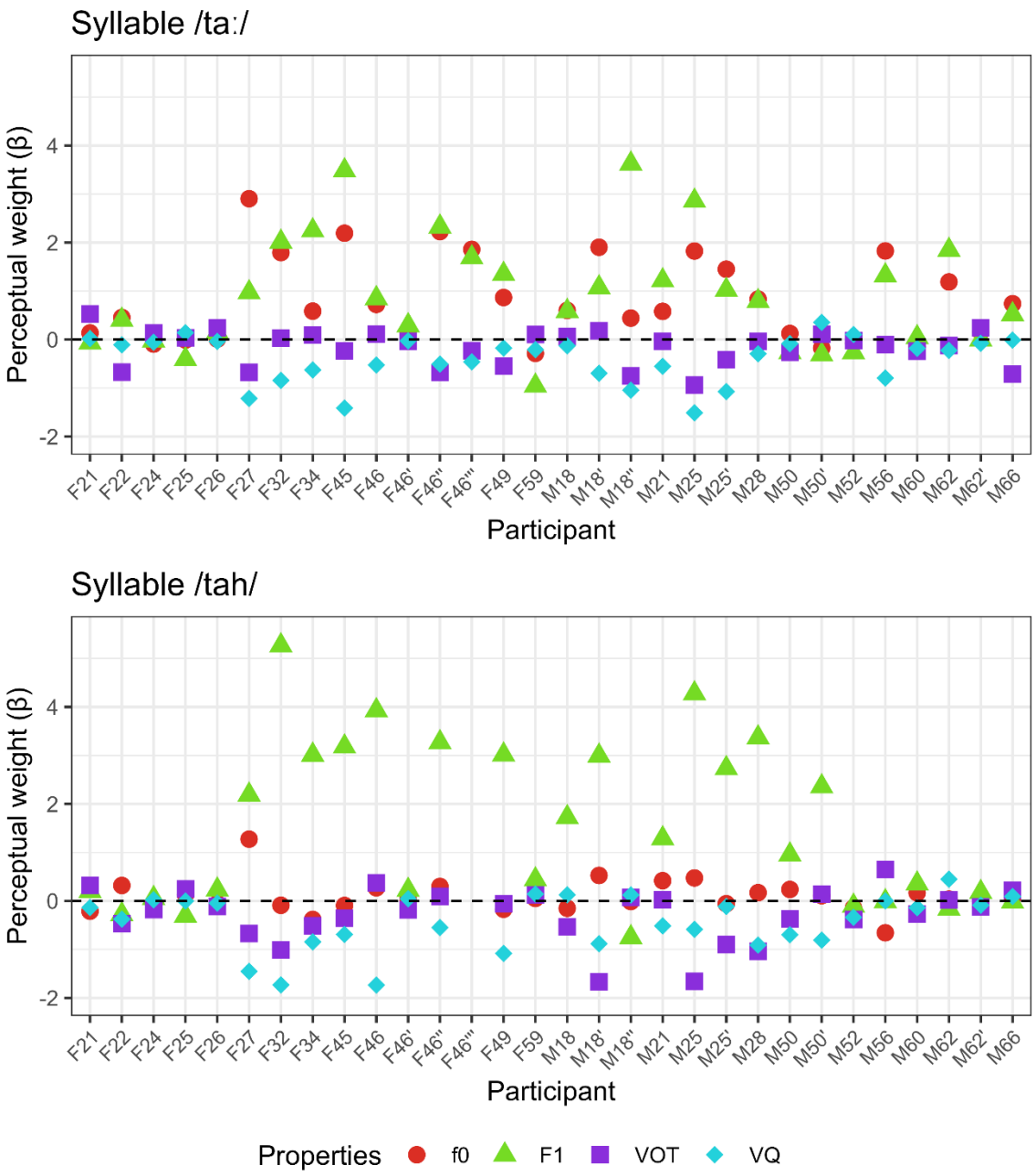


Figure 5-26. Individual variation in the perceptual weights (estimated log odds) of f0, F1, VOT, and VQ in identifying high- and low-register tones by *speaker* and *syllable*. Participants' numbers indicate sex (M/F), followed by age at the time of the experiment (2021); the apostrophes differentiate same-age participants.

Besides general patterns shown in Figure 5-25, Figure 5-26 reveals that the effects of the manipulated parameters differ between participants. For both /ta:/ and /tah/ sets, the log odds of the four parameters are not clearly distinctive for the five youngest female listeners (five leftmost ones). The same thing is observed with the five oldest male listeners (six rightmost ones, excluding M56) for the /tah/ set. While we could attribute the effect of age to hearing loss ability in older listeners, the reason I can think of for the absence of robust perceptual weights in younger female listeners is their shyness and unfamiliarity with the experiment setting (interacting with laptop, headphones, and with myself and other people around). Recall that the data from the listeners whose results show no siginificant effect in any of the manipulated properties were excluded before running the statistical tests for the grand dataset (Section 5.3.1).

Notwithstanding these difficulties in carrying out the identification task, F1 is the most salient cue in both stimuli sets. However, participants vary as to which property they use as the second most prominent cue and as to its salience.

To determine to what extent there is a match between production and perception weights at the individual level, estimated log odds of main factors for each individual were plotted against the corresponding Cohen's *d* scores calculated at the first sampling point of the vowel /a/ in four syllables /ta:^{A1}/, /ta:^{A2}/, /tah^{C1}/, and /tah^{C2}/ (Figure 5-27).

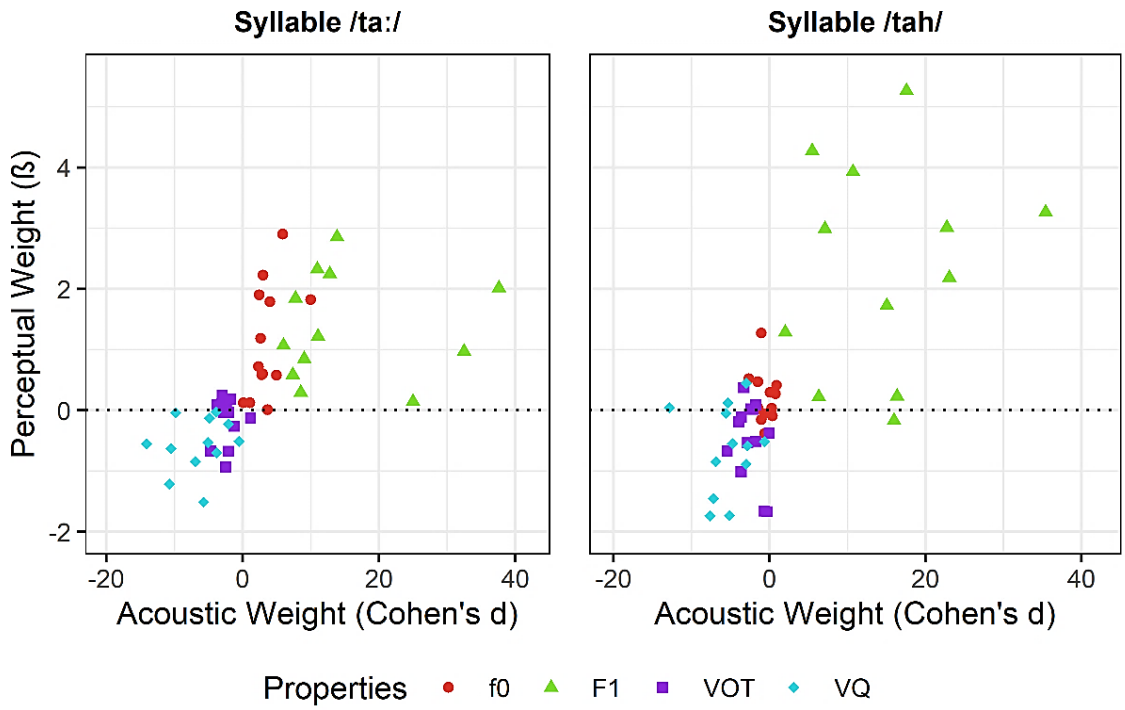


Figure 5-27. Correlation between perceptual weight (β) and acoustic weight (Cohen's d) of individual participants for the vowel /a/ in the four target syllables. VQ stands for phonation (voice quality) and represents the acoustic property H1*-H2* on the x-axis and the OQ (open quotient) of the synthesized stimuli on the y-axis.

The x-axis, which represents individual acoustic weights (Cohen's *d*) in Figure 5-27, reveals some information not available in Section 5.2.2.4 because of the breakdown between A and C tone pairs. Cohen's *d*'s for F1 are high for both tone pairs; there are even some extremely high scores. By contrast, most of Cohen's *d* scores for f0 in the C tones (the syllable /tah/) are close to 0, indicating the absence of an f0 difference between tone C1 and C2. Voice quality is also used consistently across speakers in differentiating the two tonal pairs, although some null effects (Cohen's *d*s around 0) can be observed in both pairs. VOT is longer in high tones than in low tones, as illustrated by negative Cohen's *d* scores; however, some speakers show a null effect for this acoustic property as well. Individual perceptual weights (on the y-axis) are identical to those plotted in Figure 5-25

and were discussed in the preceding paragraphs.

Generally, most participants use F1 and f0 in /ta:/ and F1 in /tah/ as the most prominent cue(s), both in their production and perception. There is, therefore, a general match between production and perception. However, there is no correlation within cues in the sense that the greater use of a cue in production does not entail a greater use in perception, and vice versa (Table 5-20). In other words, the participants use a range of acoustic cues in their production and perception of the tonal pairs, but the relationship between the two modalities is not straightforward.

Table 5-20. Results of correlation tests for f0, F1, VQ, and VOT between individual production and perception weights, by *syllable*.

	Syllable /ta:/		Syllable /tah/	
Properties	*r*	*p-value*	*r*	*p-value*
f0	0.1	0.49	0.05	0.75
F1	0.03	0.84	0.05	0.73
VQ	0.08	0.59	0.05	0.84
VOT	0.04	0.8	0.00	0.99

5.3.4.2 Group variation

The production and perceptual weights of the four phonetic properties involved in the Rục tonation contrast were broken down by demographic groups and tone categories (A and C categories in the two syllables /ta:/ and /tah/ respectively) and illustrated in Figure 5-28. Here I am mainly interested in whether some phonetic cues have different relative importance in production and perception, because such cue-weighing mismatches could inform us about the initiation of a sound change (restructuring tonation cues, cf. Section 5.3.1).

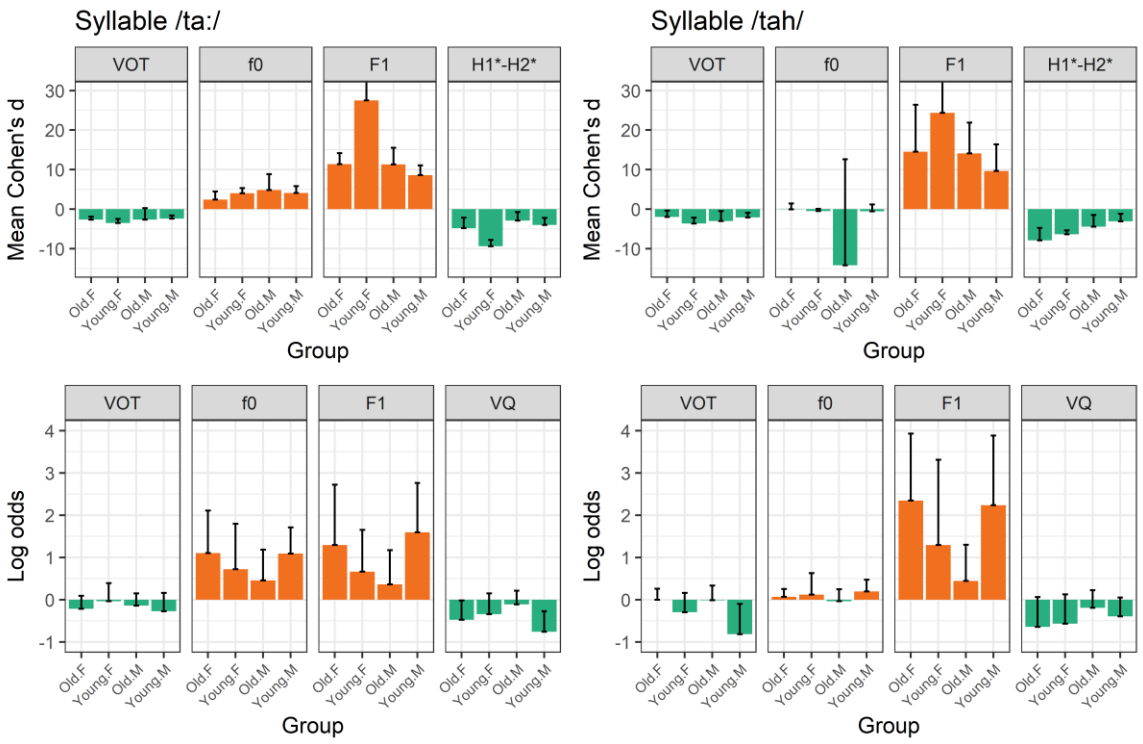


Figure 5-28. Comparison of average production (upper) and perception (lower) weights for four phonetic properties in syllable /ta:$^{A1/A2}$/ (left) and /tah$^{C1/C2}$/ (right), by *age* and *sex*. (Old participants are born before 1974). Negative values are in green and positive values are in orange. The confidence interval in young women's production weights for F1 in both syllables is truncated for better visualization.

Besides results already noted in the above sections, one can note in the upper panel of Figure 5-28 representing production weights (Cohen's d scores), that young women have a more marked F1 difference between tones in the two registers than other age and sex groups. In syllable /ta:/, they also have the largest scores for H1*-H2* and VOT, but not for f0. In syllable /tah/, young women also have a slightly higher score for VOT than other groups. Together, these patterns indicate that young women strongly weigh all available phonetic properties and realize the register distinction more clearly than the other groups.

It is important to note that for syllable /taː/ (left column in Figure 5-28), the perceptual weight of f0 is heavier than its production weight in relation to those of F1. In production, f0 is always less prominent than F1 in all four groups, but its perceptual weight approaches that of F1 and even exceeds F1 in young women. This seems to suggest that listeners started shifting their perceptual attention to f0, which could be a sign of initiation of a perception-led sound change (Ohala, 1981; Ohala, 1989; Beddor, 2009; Ohala, 2012; Pinget, 2015).

However, this result does not necessarily extend to other syllables and tone categories. F1 is still the determining property in both production and perception in /tah/ (right column in Figure 5-28). For tone B and D categories, which were not included in this perception study, their tones in the two registers are clearly distinguished in production by f0 contour. The relative perceptual prominence of tonation cues for these tone categories will be investigated in future studies.

5.3.5 Summary of the perception results

The results of the identification experiment reveal that the perception of tone/register distinction in Rục varies between the two tested tonal pairs of A1 vs. A2 and C1 vs. C2, which roughly mirror the differences in their production. The perception of the two A tones is mainly conditioned by F1 and f0, the two most salient differences in production. F0 does not play an essential role in the perception of the two C tones, reflecting the fact that it does not significantly distinguish them in production. As f0 does not play a role, F1 comes to compensate and becomes even more prominent for the C than for the A tone pair. Voice quality significantly affects identification responses in both tested tone pairs, though to a

lesser extent than the effect of F1.

The small but significant effects of 20 and 30 ms VOTs and their interactions with other acoustic cues, along with the most salient effect of F1, suggest that Rục participants use a wide range of cues, both suprasegmental and segmental, to perceive the tonal/registral contrast. In other words, from a perception point of view, as well as from the production perspective (Section 5.2.3), it is better to treat the prosodic system of Rục as a hybrid one of tone and register, which points to the "missing link" (Mazaudon & Michaud, 2008) between tonogenesis and registrogenesis.

Significant individual variation was observed in the weighting of perceptual cues in both tested syllables, but the general tendency remains that the most salient cues in production and perception are roughly the same. However, no direct link between the salience of individual production and perceptual weights within phonetic cues was found in the sense that a higher production weight does not entail a corresponding high perception weight.

5.4 General discussion and interim

5.4.1 Rục as a link between tonogenesis and registrogenesis

The results of the production study allow me to answer the first question on the phonetic realization of the tonal/registral system of Rục. In open syllables, Rục has four tones differentiated by a bundle of phonetic cues, including f0 height, f0 contour, phonation type (onset breathiness and final glottalization), vowel quality, and, to some extent, vowel duration and VOT. These four tones have already been described in previous studies of the

Rục tone system, but the researchers differed in which phonetic characteristics they attributed to which tone. My results contribute to the understanding of the Rục tone system because of the systemic distinctions found between the high-register tones, A1 and B1, and the low-register tones, A2 and B2. Particularly, the two low-register tones always have a breathier phonation type at vowel onset and higher or more diphthongized vowels than their high-register counterparts. Vowels also tend to be longer in the low- than high-register tones. Both tones in the B category have moderate final glottalization, a remnant of their origin from the historical final glottal stop *-ʔ. In addition to the vocalic differences between the high- and low-register tones, onset stops show an expected difference by which VOT is longer in syllables with low- than high-register tones. This is again reminiscent of the VOT difference observed in many registral languages (Abramson et al., 2007; Brunelle et al., 2019; Brunelle & Tạ, 2021; Tạ et al., 2022).

One of the most striking findings in this study is that h-ending syllables (C1 and C2 tones) have a high-level f0, regardless of their original onsets. These f0 height and contour profiles differ radically from A1 and A2, the two falling tones of which they are sometimes considered allotones. There is no significant f0 difference between C1 and C2, so if f0 is regarded as a mandatory tone cue, C1 and C2 cannot be two distinctive tones. However, this tonal pair exhibits precisely the same differences in phonation type, vowel quality, and vowel duration found between the two pairs of A and B tones. In particular, vowels with the C2 tone have a breathier phonation type, are higher or falling-diphthongized, and have a longer duration.

Tonogenesis in its traditional sense has only developed halfway in Rục: /-h/ is still preserved, resulting in only four falling and rising tones A1, A2, B1, and B2. In addition,

the loss of an onset voicing contrast gave rise to the register distinction in h-ending syllables and register-plus-f0-height-and-contour in open syllables. These two phenomena lead to the conclusion that the Rục tonation system should be treated as a complex/hybrid system combining tone and register. The language is a "missing link" (Mazaudon & Michaud, 2008) between tonogenesis and registrogenesis. Furthermore, the fact that there is a systematic register contrast across Rục syllables while the only contrastive tones that have developed from finals are B1 and B2 suggests that register is diachronically older than tone in that language.

Although the number of tokens of words with checked syllables included in this study is not sufficient for robust statistical conclusions, an inspection of some words confirmed that the two tones in these syllables, D1 and D2, exhibit the same systemic distinction between the high and the low registers as the A and B tone pairs in terms of f0 height, f0 contour, phonation type, vowel quality, vowel duration, and VOT.

5.4.2 Perception reflects production

The second and third research questions can be answered with the results of the perception experiment (§5.1.4).

The results of the perception experiment showed that Rục listeners use f0, F1, phonation type, and VOT as acoustic cues to perceive the distinction between A1 and A2 tones, with F1 being the most prominent cue, followed by f0 and phonation. VOT also plays a minor role in perception. F1 is also the most salient cue affecting listeners' perception of the two C tones, followed by phonation and VOT. F0, on the other hand, has a minimal effect compared to that of f0 in the two A tones. This is expected given that f0

does not distinguish C1 and C2 in production.

The order of salience of perceptual cues in the two tonal pairs mirrors the distinction in their production. Therefore, one can say that there is a general match between production and perception cue weights in the Rục tonation system (Schertz & Clare, 2020). However, no correlation was found between individual weights for a given cue, reflecting the fact that a high production cue weight does not necessarily entail a corresponding high perceptual weight (§5.3.3).

There is also evidence of cue shifting when the perceptual weight of f0 increases relative to that of F1 in A tones. This change does not apply to C tones, where f0 has a negligible effect on listeners' perception. Future research should investigate cue shifting in the other two tone categories, B and D, and with a larger sample size in order to determine whether there is an initiation of sound change (restructuring tonation cues) in the Rục community.

Chapter 6

Tone and vowel systems in Vietnamese dialects

In this chapter, I study the tone and vowel systems of three North-Central Vietnamese dialects, Cổ Định (Thanh Hoá province), Nghi Ân (Nghệ An province), and Diêm Điền (Quảng Bình province). My goal is to determine if the phonetic properties of these dialects provide evidence to determine if Proto-Việt-Mường (PVM hereafter) already had a register contrast, like all other Vietic varieties, or if it had a voicing contrast, as assumed in most models of Vietnamese tonogenesis since Haudricourt (1954b). I first review previous work on North-Central Vietnamese dialects in **6.1**, focusing on tone and vowel systems. Section **6.2** details the methodology. In section **6.3**, I analyze the tone systems of these three dialects, showing different patterns of tone confusion/merging and different applications of phonetic properties in realizing tones. These tone patterns inform us about the development of tone in these dialects and in Vietnamese in general. The most relevant results will be the following: (i) the characteristic merger between C1

and C2 in Cổ Định, and more generally, in Thanh Hoá dialects; (ii) the merger between B2 and C2 after tonogenesis is characteristic of Nghi Ân, and more generally, in Nghệ Tĩnh dialects; and (iii) Vietnamese had a register contrast at some point that left traces of breathiness in the low-register tone A2 in Diêm Điền, a non-modal phonation that has also been reported in Northern Vietnamese A2. In Section **6.4**, I track the development of vowels from Proto-Vietic to standard Northern Vietnamese and show that the ancestor of this Northern dialect (PVM) did not have register-conditioned vowel changes like other Vietic languages (and other Austroasiatic register languages). Section **6.5** summarizes the results of this chapter and their implications for a better understanding of tonogenesis and registrogenesis in Vietnamese. I conclude that the overall evidence favours the reconstruction of an Austroasiatic register system rather than an onset voicing contrast in PVM but that this register system was already phonetically more simple than that of other Vietic languages.

6.1 Introduction

6.1.1 North-Central Vietnamese dialects

Opinions on how to go about dividing Vietnamese into major dialect groups vary greatly between authors (Cadière, 1902, 1911; Maspero, 1912; Nguyễn, 1949; Emeneau, 1951; Thompson, 1965; Vũ, 1981; Nguyễn, Nguyễn, & Nguyễn, 1982; Nguyễn, 1995; Hoàng, 2004, among others). Nonetheless, Vietnamese is usually considered to be comprised of three main dialectal regions: Northern, Central, and Southern Vietnamese (Hoàng, 2004) (see Figure 6-1). The provinces of Thanh Hoá and Thừa Thiên Huế are the northern and southern limits of the

Central region, respectively (Figure 6-2). Some authors claim that these two provinces are transitional areas between the Northern and Central and the Central and Southern dialect continua since they share linguistic characteristics, phonetics, lexicon, and phonemic inventories with neighbouring regions (Phạm, 1985; Hoàng, 2004).

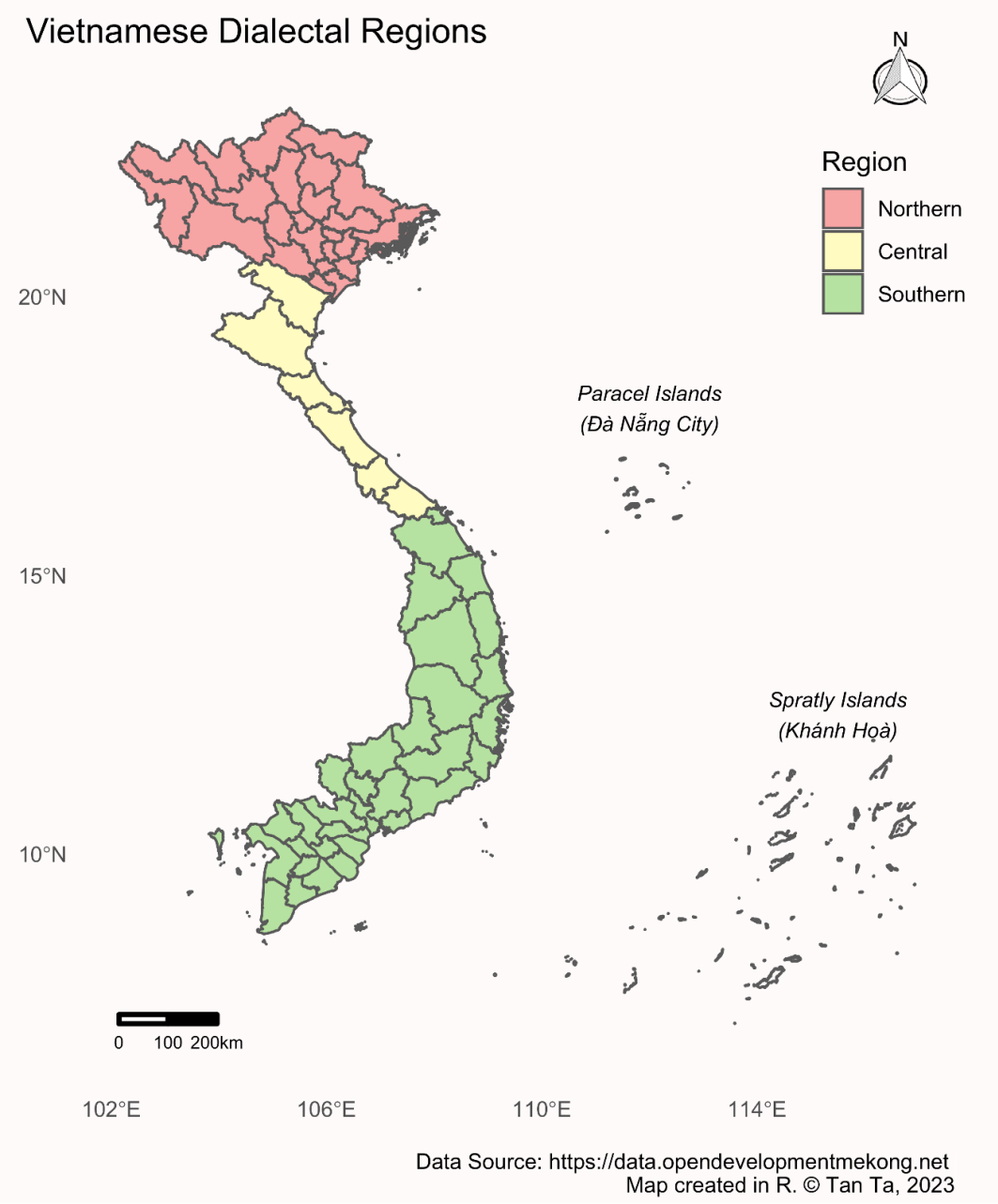


Figure 6-1. Three Vietnamese dialectal regions.

I adopt the view that the Central dialectal region covers six provinces, Thanh Hoá, Nghệ An, Hà Tĩnh, Quảng Bình, Quảng Trị, and Thừa Thiên Huế (Figure 6-2). Like the Northern and Southern regions, the Central region is not homogenous but comprises various dialects and local varieties. Based on general lexical, phonetic, and phonological criteria, the Central region is further subgrouped into three dialectal sub-regions, or, in Vietnamese terms, three "giọng" (accents): 1) Thanh Hoá, 2) Nghệ Tĩnh (i.e., Nghệ An – Hà Tĩnh), and 3) Bình Trị Thiên (i.e., Quảng Bình, Quảng Trị, and Thừa Thiên Huế).

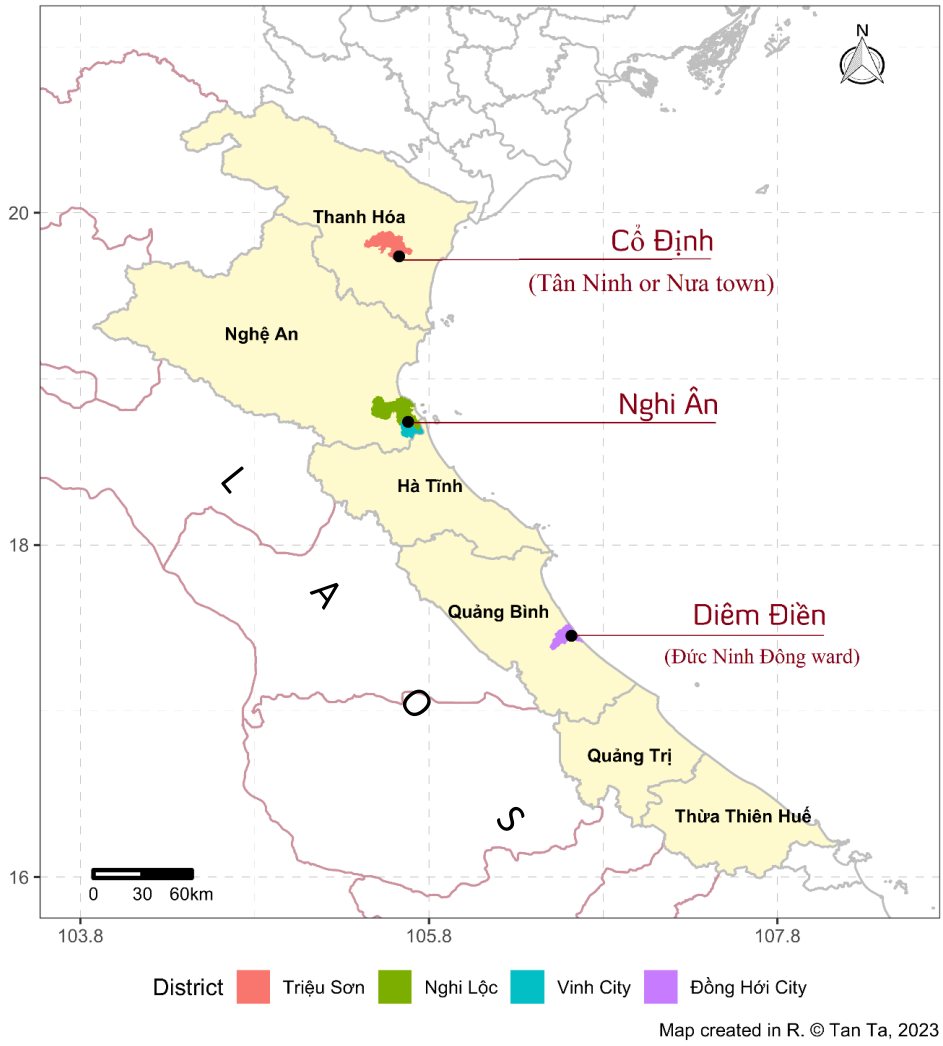


Figure 6-2. Central Vietnamese dialectal region and the location of three varieties studied in this dissertation.

The Thừa Thiên Huế dialect of the Bình Trị Thiên subregion is often considered the stereotypical Central dialect due to its geographical location (nearly right in the middle of Vietnam) and its cultural and historical prestige (Huế was the capital of the Southern Vietnamese polity from 1687 to 1945); and therefore it has attracted much attention from linguists (Taylor, 1962; Thompson, 1965; Vũ, 1981; Võ, 1997; Nguyễn, 2012). Even though Thừa Thiên Huế is considered typical of Central Vietnam, it will not be studied in this dissertation as it does not contain the registral features I am interested in. The Diêm Điền dialect studied below is geographically located in Đồng Hới city, Quảng Bình province, which is also in the Bình Trị Thiên subregion, but its speakers originally came from Thái Bình (North Vietnam) and Thanh Hoá and moved to Quảng Bình about 400 years ago, and it, therefore, seems to pattern structurally, at least to some extent, with Thanh Hoá dialects.

The other two dialectal subregions of Central Vietnam, Thanh Hoá and Nghệ Tĩnh, are collectively referred to as North-Central Vietnamese (Võ, 1997; Hoàng, 2004; Alves, 2007; Alves & Hương, 2007)[23]. In this chapter, I study two North-Central Vietnamese dialects, the Cổ Định dialect in the Triệu Sơn district (Thanh Hoá) and the Nghi Ân dialect in the Nghi Lộc district (Nghệ An).

The Nghệ Tĩnh dialect is the most studied of all non-standard Vietnamese dialects. Previous studies focused mainly on its lexicon, phonemic inventory, and tone system since it is considered to preserve the most archaic properties of all Vietnamese dialects (Nguyễn, 1995; Hoàng, 2004; Nguyễn, 2005). Nguyễn (1995) explained this uniqueness of the Nghệ Tĩnh dialect by proposing that it branched out from pre-Việt-Mường later than other Vietnamese

[23] Some authors consider North-Central Vietnamese as including a larger region extending from Thanh Hoá to Quảng Bình province (Alves, 2007; Alves & Hương, 2007), while still many others take the position that North-Central Vietnamese should be used to referred to the Nghệ An – Hà Tĩnh accent only (Hoàng, 2001a; Honda, 2008).

dialects, which also underwent more extensive influence from Chinese. Pre-Việt-Mường as spoken in Nghệ Tĩnh then split into "Vietnamese" in the plains and coastal region and Mường dialects in the mountainous regions, and the former underwent more substantial influence from Northern Vietnamese than the latter and converged with it to a large extent. The late formation of Nghệ Tĩnh Vietnamese from pre-Việt-Mường would partly explain why it retained more traits of the pre-language than Northern dialects.

The Thanh Hoá dialect, although included in the North-Central dialect, has until recently received less attention than the Nghệ Tĩnh dialect because of its position in a transitional zone between the North and Central dialectal regions (Phạm, 1985; Hoàng, 2004). As I will show in the results section, dialects in Thanh Hoá and Nghệ Tĩnh are very similar in preserving an older lexical layer and more archaic phonological traits than the Northern dialects. They also share vowel changes that are not found in the Northern dialects. Based on linguistic similarities between these two subdialectal areas, I will refer to them with the cover term *North-Central Vietnamese*, even if they have significant differences, the most relevant here being the pattern of confusion/mergers in their tone systems: Thanh Hoá dialects usually have a five-tone system, where C1 and C2 tones have the same phonetic realization[24], while Nghệ Tĩnh dialects and sub-dialects have a single phonetic realization for B2 and C2 tones. The five-tone system with merged B2 and C2 tones[25] as spoken in Nghệ Tĩnh is unique in Vietnam since other dialects with a five-tone system in Bình Trị Thiên and Southern Vietnamese follow the tone pattern of Thanh Hoá (Võ, 1997; Hoàng, 2004). I am not aware of any holistic comparison of the Thanh Hoá and Nghệ Tĩnh dialects,

[24] I am not using the term "tone merger" as it has not been clear whether C1 and C2 were once distinct tones and then merged in the dialect, or there was only single C-tone reflex from the very beginning.

[25] Since there are distinctions between B1, C1 and B2-C2 tones in these dialects, there was probably an original split between B tones and C tones, followed by a merger of B2 and C2.

but in the following table (Table 6-1), I list core studies and publications that focus on either their tone systems and/or phonology and lexicon.

Table 6-1. Core studies on North-Central Vietnamese dialects.

Studies	*Focus*	*Study on phonology and/or lexicon*	*Study on tone system*	
			Auditory	Experimental
Vũ (1981)	Nghệ An, Quảng Bình, Huế	x	x	✓
Nguyễn (2005)[26]	Thanh Hoá, Nghệ An	✓	x	x
Hoàng (2004)[27]	Thanh Hoá, Nghệ An	✓	✓	x
Trần and Thái (1998b)	Nghệ An	✓	x	x
Võ (1993)	Nghệ An	✓	✓	x
Nguyễn (1995)	Nghệ Tĩnh, Bình Trị Thiên	✓	x	x
(Alves, 2007; Alves & Hương, 2007)[28]	Nghệ An	✓	✓	x
Hoàng (2001a)	Nghệ Tĩnh	✓	x	x
Nguyễn (2002)	Nghệ An	x	x	✓
Nguyễn (2003)	Nghệ Tĩnh	✓	✓	x
Lê (2003)	Nghệ An	x	✓	x
Phạm (2004)	Nghệ An	x	✓	x
Pham (2005)	Nghệ An	x	x	✓
Lê (2005)	Thanh Hoá	x	✓	✓
Trần (2006)	Thanh Hoá	✓	✓	x
Honda (2006, 2008)	Nghệ Tĩnh	x	x	✓
Nguyễn and Nguyễn (2008)	Thanh Hoá	x	x	✓
Nguyễn (2009c)	Thanh Hoá	x	✓	✓
Lê (2010)	Thanh Hoá	✓	✓	✓
Nguyễn (2018)	Hà Tĩnh	✓	x	✓

In the following two sections, I summarize some crucial results from these previous studies on the tone and vowel systems of Thanh Hoá and Nghệ Tĩnh dialects.

[26] This book was published based on Nguyễn's dissertation written in 1982.
[27] The first edition of this publication was in 1989.
[28] First editions of these two publications appeared in *The 12th Annual Meeting of the Southeast Asian Linguistics Society,* 2002.

6.1.2 Tone systems in North-Central Vietnamese

The tone systems of Thanh Hoá are underdocumented, while those of Nghệ Tĩnh have long attracted researchers' attention. However, as mentioned above, a defining property that separates the Thanh Hoá and Nghệ Tĩnh dialects is that, although they both have five tones, the Thanh Hoá dialect usually realizes C1 and C2 identically, while the Nghệ Tĩnh dialect often shows confusion between B2 and C2. Many dialects and sub-dialects in Nghệ Tĩnh show additional patterns of tone confusion, leading to four- or even three-tone systems (Ferlus, 1995, 1998b; Pham, 2005; Nguyễn, 2006).

6.1.2.1 Descriptions of tone systems in Thanh Hoá dialects

Trần (2006) provided impressionistic descriptions of the tone systems of several villages in the Hậu Lộc district, Thanh Hoá province. She claimed that Hậu Lộc A1, A2, B1, and B2 are phonetically identical to the corresponding tones of the standard Northern dialect. C1 is not distinct from C2 and is similar to either Northern C1 or C2, depending on adjacent tones. This all needs to be verified experimentally, but the author's descriptions support the idea of a fusion between C1 and C2 and the variability of the resulting tone in Hậu Lộc.

Nguyễn and Nguyễn (2008) described the tone system of the Vĩnh Thịnh dialect in the Vĩnh Lộc district. As far as I know, this is the first experimental study on Thanh Hoá tone. The results of this study were repeated in Lê (2010) and are summarized in Table 6-2. This dialect has a single tone (combined C1-C2) for the C category, whose f0 contour (325) is similar to C2 in standard Northern dialects but without marked phonation. The most peculiar tone is B1, a falling tone ending with a glottal stop, just like B2. The final glottal stop found at the offsets of both B1 and B2 constitutes another piece of evidence for the

historical source *-ʔ of these two tones in Vietnamese. However, judging from the two spectrograms of B1 and B2 tones provided in the paper, this final glottal stop might just be creaky phonation.

Table 6-2. Tone system of Vĩnh Thịnh (Vĩnh Lộc, Thanh Hoá) as described by Nguyễn & Nguyễn (2008).

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*	*D category (checked)*
Series 1[29] *(High register or voiceless onset)*	454	51ʔ	325	45 + stop
Series 2 (Low register or voiced onsets)	232	42ʔ		121 + stop

Nguyễn (2009d) provided a tone table for another Thanh Hoá dialect spoken in the Hoằng Hoá district. It is reproduced in Table 6-3. It confirms that there is confusion between C1 and C2 in Thanh Hoá. Note that Nguyễn described B2 as having a final glottal stop and C1-C2 as having middle glottalization, two non-modal phonations usually present in their Northern Vietnamese counterparts (Vũ, 1981, 1982; Edmondson & Lợi, 1997; Pham, 2002; Tạ, 2014).

Table 6-3. Tone system of Hoằng Hoá (Thanh Hoá). Adapted from Nguyễn (2009, p.18). No information on two checked tones, D1 and D2, was provided.

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*
Series 1 (High register or voiceless onsets)	44	35	323̰
Series 2 (Low register or voiced onsets)	32	32ʔ	

[29] *Series 1* and *Series* 2 will be used to refer to two tone groups whose etymological sources are either the high register or voiceless onsets and the low register or voiced onsets at PVM, respectively. To the end of this chapter, I will argue that PVM, the ancestor of Vietnamese and Mường dialects, already had a register contrast that led to the split of tones into high and low-register groups, instead of a voicing contrast as usually assumed to be lost after tonogenesis from glottal codas since Haudricourt (1954b).

Nguyễn (2009c) described the tone systems of several local varieties of the Thọ Xuân dialect in Thanh Hoá. These systems all have five tones, with identical C1 and C2. She reported that several varieties have a final glottal constriction in both B1 and B2, as in the Vĩnh Thịnh dialect, and that older speakers in other varieties realized C1-C2 as a rising tone.

These studies concur that Thanh Hoá dialects have five-tone systems in which C1 and C2 are indistinct. The final glottal stop or final glottalization frequently found at the offset of B1 and B2 provides evidence for the *-ʔ origin of these B tones in Vietnamese (recall that B1 does not have a marked phonation in Northern and Southern dialects). However, the exact phonetic characteristics of tones in Thanh Hoá call for a more systematic and in-depth study. In this chapter, I will describe the tone system of the Cổ Định dialect in the Triệu Sơn district to fill this gap.

6.1.2.2 Descriptions of tone systems in Nghệ Tĩnh dialects

Several tone systems belonging to the dialect area that spans the provinces of Nghệ An and Hà Tĩnh have been studied. However, this literature either consists of impressionistic descriptions (Võ, 1993; Nguyễn, 2003; Hoàng, 2004; Alves, 2007; Alves & Hương, 2007), descriptions supported by partial phonetic evidence (Nguyễn, 2018), experimental studies with a single speaker per dialect (Nguyễn, 2002; Pham, 2005) or reports in which results from speakers of various dialects are aggregated (Vũ, 1981, 1982; Honda, 2008). In what follows, I review some studies on the tone systems of the Nghệ Tĩnh subregion in general and then narrow down the discussion to the speech of the Nghi Lộc district in Nghệ An, to which the Nghi Ân dialect investigated in this dissertation belongs.

I estimate that Vũ (1981, 1982) included four speakers from Nghệ An in his dataset for Central Vietnamese based on the map in which he reported his informants' location.

Unfortunately, the results from these speakers were lumped together with those of speakers from other Central Vietnam provinces (Quảng Bình, Quảng Trị, and Thừa Thiên Huế). As the Nghệ Tĩnh dialects usually confuse B2 and C2, while other Central and Southern Vietnamese dialects confuse C1 and C2, Vũ's work should be treated with care. The effect of his radical data aggregation method is shown in Figure 6-3, in which "Central Vietnamese" only exhibits confusion between C1 and C2.

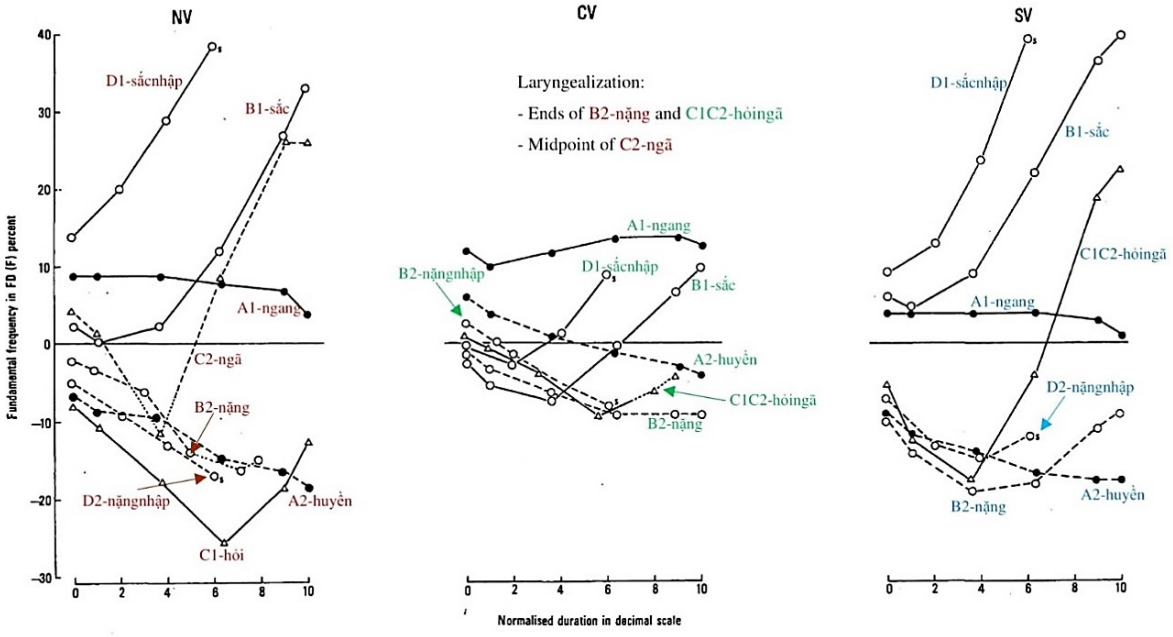


Figure 6-3. Tone systems of Nothern (left), Central (middle), and Southern (right) Vietnamese. F0 was normalized across dialects. Reproduced from Vũ (1981) with additional annotation.

Despite these limitations, Vũ (1981, 1982) captured several properties shared by tone systems in Central Vietnam: a crowded tonal space (smaller f0 range than those of Northern and Southern Vietnamese), the high f0 level of A1, and final glottalization at the offset of the falling tones, B2 and C1-C2. These features were confirmed in later experimental studies that focused on specific Central dialects, including those in Nghệ An (Nguyễn, 2002; Honda, 2008), Hà Tĩnh (Honda, 2008; Nguyễn, 2018), and Huế (Nguyễn, 2012).

Nguyễn (2002) compared the tone systems of five speakers from four districts of Nghệ An. Non-modal phonations, like breathiness, glottalization, and the glottal stop, were claimed to be present in four out of five unchecked tones in Nghệ An. However, the characterization of the tones as having non-modal phonation was based on visual inspection of the spectrograms only, and the presence of a breathy phonation in A2 was not sufficiently demonstrated. Nguyễn generalized his observation to a pan-Nghệ An tone system, reproduced in Table 6-4.

Table 6-4. Tone system of Nghệ An. Tones include non-modal phonations: breathiness (A2), creakiness (B1, C1), and final glottalization (B2-C2). Adapted from Nguyễn (2002).

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*	*D category (checked)*
Series 1 (High register or voiceless onsets)	45	32̰4	32̰	435
Series 2 (Low register or voiced onsets)	4̰3	31ˀ		32

Alves (2007); Alves and Hương (2007) are two studies focused on the phonological inventory of North-Central dialects, particularly local varieties in the Nghệ An province. The authors reported only one dialect from the Nghi Khanh commune (Nghi Lộc district) with the expected tone confusion between B2 and C2 as is characteristic of Nghệ An dialects. Other dialects were reported as merging C1 and C2, like in Nam Đàn and Thanh Chương dialects. The other two varieties in Nghi Lộc also seemingly merge C1 and C2, differing from Nam Đàn and Thanh Chương ones in that their C2 has a variant with final glottalization. Final glottalization was claimed to be present in B1, D1, B2, and C2 in these Nghệ An dialects. The descriptions of these tone systems need to be verified experimentally. However, it needs to be emphasized that these are the first studies focusing

particularly on North-Central dialects and providing a systematic description of their phonology and comparison with other Vietnamese dialects and other Vietic languages in the region as well.

Honda (2008) is a study of the tone system used around the Lam River, the natural border between two provinces, Nghệ An and Hà Tĩnh. He called the varieties spoken in this region *Lam River speech*, as he considered it relatively consistent and homogeneous despite local variations. His study included 12 speakers from three districts in Nghệ An and three districts in Hà Tĩnh, and they were not controlled for sex and age. The normalized f0 of tones aggregated from all speakers are illustrated in Figure 6-4, and their characteristics are summarized in Table 6-5.

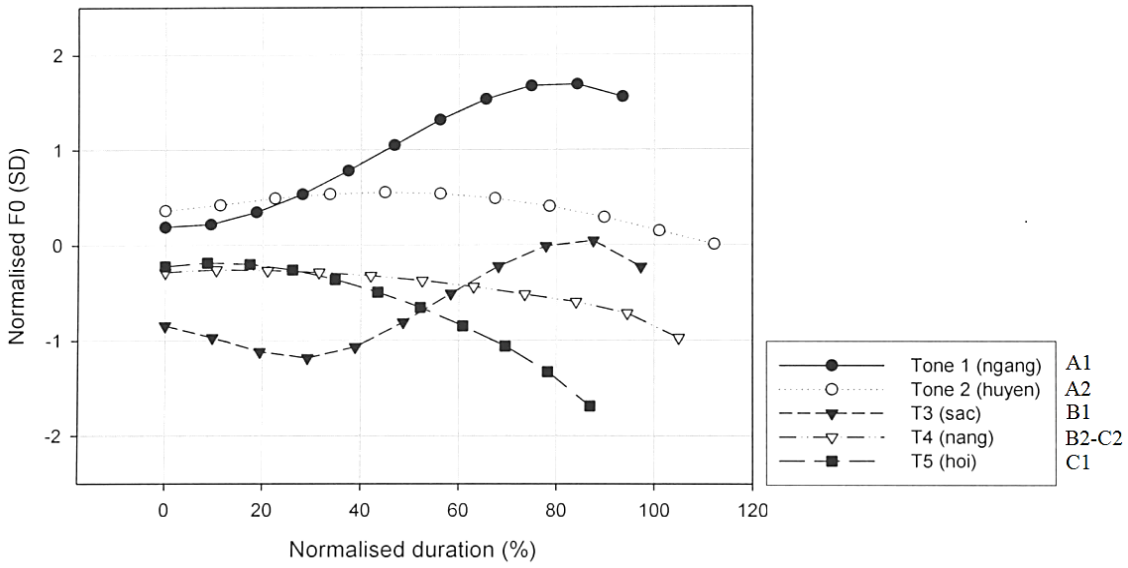


Figure 6-4. Normalized f0 and duration of tones of the Lam River speech (Honda 2006).

Table 6-5. The phonetic properties of tones of the Lam River speech, summarized the results from Honda (2006).

A1	High-rising or falling-rising; falsetto quality at f0 peak; -h at tone offset
A2	Level; modal phonation; -h at tone offset
B1	Falling-rising or low-rising; laryngealization at the lowest f0 at tone onset and offset
B2-C2	Mid-level or mid-falling; free variation of non-modal phonation (breathy, creaky, or stiff voice)
C1	Mid-falling; lowest pitch offset; final creaky or glottal stop
D1	Higher and shorter than B1
D2	Higher and shorter than D2

Non-modal phonation was frequent in the data, but it usually accompanied tones at extreme f0 values. Honda reported a falsetto voice at the f0 peak of A1, non-modal phonation (breathy, creaky, stiff voice, or even glottal stop) at the bottom f0 range in B1, B2-C2, and C1, and even a final fricative -h at the end of A1 and A2. Because of these f0-phonation cooccurrences, he concluded that phonation is not contrastive but highly correlated with f0 in Lam River speech, even if it is deliberately employed to enhance tonal distinctiveness (Honda, 2008, p. 84).

Nguyễn (2018) described the tone systems of four dialects in the Lộc Hà district, Hà Tĩnh province. Variations between these tone systems are observed, but they share some phonetic properties. All have five tones in unchecked syllables, like other Nghệ Tĩnh dialects. Final glottal stops (actually a creaky phonation or strong glottalization, judging from the spectrograms provided) were found in tones B1 and C1. B2-C2 is a falling tone, unmarked in phonation.

Let us now turn to previous work on the tone systems in the Nghi Lộc district in

Nghệ An province. Researchers usually consider Nghi Lộc as having the most representative tone system of Nghệ An dialects, and the Nghi Ân dialect, which I study in this chapter, in turn, is considered to have the most stereotypical tone system of all Nghi Lộc varieties.

Võ (1993) was the first study focusing on the phonetic properties of Nghi Lộc tone systems. He claimed that there are only four tones in these dialects because of the confusion between B1 and C1, and B2 and C2. Võ's position on the confusion between B1 and C1 was shared by Lê (2003), who studied the Nghi Ân dialect spoken in the Nghi Lộc district, but was contradicted by Nguyễn (2003) in a larger-scale study providing descriptions of tones in many dialects of the provinces of Nghệ An and Hà Tĩnh. Unfortunately, none of these three studies provide experimental evidence.

Pham (2005) provided preliminary experimental descriptions of the tone systems of Nghi Trung and Quán Hành dialects in the Nghi Lộc district. Her data was recorded from one Nghi Trung woman and one Quán Hành man. Pham showed that the Nghi Trung dialect has mergers of B1 and C1, and of A2, B2, and C2, resulting in a three-tone system. The Quán Hành dialect has a less radical pattern of tonal merger (B1-C1 and B2-C2), leaving the dialect with four tones. Pham suggested that there may be contrastive breathiness in some tones but did not establish this with acoustic measures. She did not report creakiness in any tone of these two dialects.

Lê (2003) provided a description of the tone system of the Nghi Ân dialect, assuming that it is representative of the speech of the Nghi Lộc district[30]. Her work was reproduced with minimal changes in Phạm (2004). Lê claimed that the Nghi Ân dialect has only four

[30] Nghi Ân was annexed by the city of Vinh in 2008.

tones, whose phonetic values are summarized in Table 6-6. Its patterns of tone merger are similar to those of the Nghi Trung dialect discussed above (Pham, 2005). She also reported glottalization at the end of B and C tones and the middle of the falling-rising variant of the A2 tone. In Section 6.3.2, I will show that the dialect only has four tones but that their f0 and phonation differ from Lê's descriptions.

Table 6-6. Tone system of the Nghi Ân dialect in Nghi Lộc, Nghệ An, summarized from Lê (2003). Glottalization is claimed to present at B1-C1 and B2-C2 offsets and in the middle of A2. No information on tones in checked syllables was provided.

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*
Series 1 (High register or voiceless onsets)	34	435 or 45ʔ	
Series 2 (Low register or voiced onsets)	33 or 32ʔ3	31ʔ	

6.1.2.3 Descriptions of tone systems in Quảng Bình dialects

Some key studies are worth mentioning in the study of tone systems of Quảng Bình dialects. The Cao Lao Hạ and Hạ Trạch varieties in the Bố Trạch district seem to have the most peculiar tone systems in the region in which B2, C1, and C2 have merged (Ferlus, 1995, 1998b), resulting in four-tone systems. Ferlus explained this tone merger as *-h being unable to split into high and low series tones, and these, in turn, became confused with the B2 tone. This seems to suggest that the loss of *-ʔ preceded that of *-h and that f0 was indifferent in syllables ending in *-h. We encountered these same patterns of tone development in Rục (cf. Chapter 5). On the other hand, Nguyễn (2006) proposed that the tone system of Cao Lao Hạ was formed first by the confusion between *-ʔ and *-h followed by onset devoicing and that these developments had been affected by a Cham substratum during the history of the community.

Michaud, Ferlus and Nguyễn (2015) is another study among limited studies on Quảng Bình tone systems which investigates the general phonology of the Phong Nha dialect (Bố Trạch district). The authors reported that this dialect has a tone confusion between B2 and C2 that is common in all Central (except Thanh Hoá) and Southern dialects. Otherwise, the study focused on the phonology of the dialect as the result of standardization and complex mixture with other Vietic languages in the region. For a description of the tone systems of Quảng Bình dialects and the broader area of the Bình Trị Thiên dialectal sub-region, readers are referred to Võ (1997).

Some dialects spoken in Quảng Bình are assumed to be related to North-Central Vietnamese. The Diêm Điền dialect in Quảng Bình is one such variety: the ancestors of its speakers originally came from Thanh Hoá (and Thái Bình in North Vietnam) around 400 years ago (Địa chí làng Diêm Điền [Chorography of Diêm Điền village], 2008), and even though it has not been studied yet, it is well known in the area and the mass media for its peculiar tone system. I decided to include Diêm Điền in my study of tone and vowel systems in North-Central Vietnamese dialects because it could have escaped the dialect levelling that occurred in Thanh Hoá after its departure and preserved the original Thanh Hoá tone features.

6.1.3 Vowel systems in Northern and North-Central Vietnamese

There are some oft-cited vowel quality differences between North-Central and the standard Northern dialect. For example, some North-Central words with open vowels /ɛː, aː, ɔː/ often have diphthongized counterparts /iə, ɨə, uə/ in the standard variety (lines 1-5 in Table 6-7),

and the North-Central close vowels /iː, uː/ often correspond to standard /ɤj, ɤw/ (lines 6-9 in Table 6-7).

Table 6-7. Examples of vowel correspondences between the standard Northern and North-Central Vietnamese dialects.

	Gloss	*Proto-Vietic*	*Standard Vietnamese*	*North-Central Vietnamese*
1	*to defecate*	*ʔɛh	iə^{C1}	ɛː^{C1}
2	*rice*	*ʔa-lɔːʔ	luə^{B1}	lɔː^{B1}
3	*intestine*	*rɔːc	zuət^{D1}	rɔːt^{D2}
4	*fire*		liə^{C1}	laː^{C1}
5	*water*	*ɗaːk	niək^{D1}	naːk^{D1}
6	*head louse*	*ciːʔ	cɤj^{B1}	ciː^{B1}
7	*you*	*miː	maj^{A2}	mi^{A1}
8	*buffalo*	*c-luː	cɤw^{A1}	ʈuː^{A1}
9	*brown*		nɤw^{A1}	nuː^{A1}

The archaic rhymes of North-Central dialects can also be found in Mường dialects and many Vietic languages (Nguyễn, 1995; Nguyễn, 2005; Trần, 2015) and even in Ferlus' reconstructed Proto-Vietic (Ferlus, 2014). However, Ferlus claimed that the vowel innovations found in standard Northern Vietnamese but not in North-Central dialects "*are not explainable by any of the conditioning or historical processes that linguists usually encounter in the Southeast Asian area*" (1997b, p. 49, my translation). On the other hand, Nguyễn (1995) claimed that onsets, mainly voiced onsets, conditioned vowel diphthongization in standard Northern Vietnamese but did not offer a systematic explanation or regular correspondences. If it could be demonstrated that Northern Vietnamese vowel innovations are conditioned by tone series (1 or 2) in ways similar to those found in ESEA register languages (Huffman, 1976, 1985b; Brunelle et al., 2020; Tạ, 2021;

Tạ et al., 2022), they would constitute evidence that, at some point, the ancestor of standard Northern Vietnamese had a register contrast that became opaque as the present tone system was formed. I therefore decided to compare the innovative vowels of standard Northern Vietnamese to those of more conservative North-Central dialects, of other Vietic languages and of Proto-Vietic to determine if there is evidence for register-based changes in standard Northern Vietnamese.

6.1.4 Research questions

In this chapter, I aim to answer the following research questions.

(1) How many tones are there, and what are the phonetic properties of tones in three target North-Central Vietnamese dialects: Cổ Định (Thanh Hoá), Nghi Ân (Nghệ An), and Diêm Điền (Quảng Bình)?

- Does the Cổ Định dialect have identical C1 and C2, as found in other Thanh Hoá dialects?
- Is it true that the Nghi Ân dialect has only four tones in unchecked syllables because of the tone mergers between B1 and C1, and B2 and C2?
- What is the number of tones in Diêm Điền, an undescribed dialect spoken in Quảng Bình that could preserve conservative Thanh Hoá features?
- How are tones realized in these three dialects in terms of phonetic properties, including f0 height, f0 contour, phonation type, vowel quality, and duration?

(2) What can the tone systems of these three North-Central dialects tell us about the phonetic properties of Proto-Việt-Mường onsets/register?

(3) Are the vowel changes that occurred from Proto-Việt-Mường to Northern

Vietnamese conditioned by a register contrast in the proto-language? If so, what implications does this finding have for understanding register contrasts in Việt-Mường and Vietic languages?

6.2 Method

6.2.1 Participants and wordlists

I designed a basic wordlist to investigate the tone systems of all three Vietnamese dialects. Some words had to be replaced to reflect lexical differences in Diêm Điền, but these changes were kept to a minimum. The target syllables include four vowels /iː, uː, ɛː, aː/ combined with the implosive onset /ɓ/ (or the nasal onset /m/ where there is a gap in the lexicon) and carry each of the eight surface tones of standard Vietnamese. Open syllables were chosen, except for the D1 and D2 categories, for which I chose the coda /t/ or /p/. I chose words that are depictable. Together these design criteria resulted in a list of 32 words, given in Table 6-8. In the recording sessions, I recorded 26 or 27 additional words in each dialect to study other linguistic phenomena. These words will not be reported here and can be considered fillers.

Table 6-8. Wordlist designed to investigate the tone systems in three North-Central Vietnamese dialects. Some other words were used for the Diêm Điềm dialect.

Tone	*Target*	*Gloss*	*Target*	*Gloss*
A1	viên **bi**	*marbles*	ruồi **bu**	*flies gathering*
A2	**bì** lợn	*pork skin*	**bù** mập	*a national park's name*
	Diêm Điền: **mì** tôm *'instant noodles'*			
B1	quả **bí**	*winter melon*	**bú** mẹ	*milking*
B2	quai **bị**	*mumps*	**bụ** bẫm	*chubby*
C1	khinh **bỉ**	*scorn*	sưng **mủ**	*swollen*
C2	nước **mĩ**	*U.S.A*	đội **mũ**	*to wear a hat*
D1	quả **mít**	*jackfruit*	cái **bút**	*pen*
D2	**bịt** tai	*to cover ears*	ông **bụt**	*buddha*
A1	**be** be	*bleat (of a goat)*	số **ba**	*three*
A2	**bè** mảng	*raft*	ông **bà**	*grandparents*
B1	em **bé**	*child*	**bá** vai	*to put hands on others' shoulders*
			Diêm Điền: cá *'fish'*	
B2	**bẹ** cau	*spathe*	học **bạ**	*school report*
C1	**bẻ** ngô	*to harvest corn*	**bả** chuột	*mouse bait*
C2	**bẽ** mặt	*to lose face*	**bã** mía	*sugar-cane dregs*
D1	nát **bét**	*crushed*	cái **bát**	*bowl*
			Diêm Điền: cát *'sand'*	
D2	**bẹp** dúm	*out of shape*	vải **bạt**	*canvas*

I recorded ten speakers for each dialect, five men and five women (Nghi Ân: four men and six women). All speakers are monolingual. I recruited participants over 40 years old in the Cổ Định and Diêm Điền dialects, but Nghi Ân speakers were younger on average. Data from one male speaker in the Diêm Điền dialect was excluded after consulting with my local assistant, as he did not pronounce words in his native dialect but switched to the more prestigious dialect of Đồng Hới, the provincial capital of Quảng Bình. The speakers' socio-demographic information is given in Table 6-9.

Table 6-9. Participants' age in 2021, by *dialect* and *sex*, (F)emale and (M)ale.

Cổ Định		*Nghi Ân*		*Diêm Điền*	
F01	55	F01	34	F01	71
F02	48	F02	43	F02	39
F03	59	F03	42	F03	62
F04	55	F04	40	F04	50
F05	47	F05	50	F05	67
___	___	F06	36	___	___
	Mean 52.8 **SD 5.1**		**Mean 40.8** **SD 5.7**		**Mean 57.7** **SD 13.1**
M01	58	M01	36	___	___
M02	60	M02	30	M02	90
M03	61	M03	45	M03	75
M04	68	M04	25	M04	78
M05	52	___	___	M05	74
	Mean 59.8 **SD 5.8**		**Mean 34** **SD 8.6**		**Mean 79.3** **SD 7.4**

A second wordlist was designed to investigate vowel correspondences between the three North-Central Vietnamese dialects and the standard Northern dialect. The wordlist is comprised of 313 lexical items that are plausibly realized with different rhymes in the dialects under study and in the standard Northern dialect (it is not meant to capture all possible interesting vocalic features of North-Central Vietnamese). These are mainly words that retain proto-vowels in North-Central dialects, but underwent vowel changes in the standard Northern dialect (Table 6-7). Some other words in the wordlist show the reverse patterns (changed vowels in North-Central dialects but retained proto-vowels in the standard Northern Vietnamese). These items were compiled from different dictionaries of North-Central dialects (Trần & Thái, 1998b; Chu, 2002; Nguyễn & Nguyễn, 2013) and studies of the North-Central vowel systems (Cadière, 1902; Maspero, 1912; Võ, 1993; Nguyễn, 1995; Võ,

1997; Hoàng, 2001a; Nguyễn, 2005; Alves, 2007; Alves & Hương, 2007). The full wordlist is provided in Appendix 6-1.

In order to answer the question of whether some vowel changes from Proto-Vietic to standard Northern Vietnamese were register-conditioned, I compiled a third wordlist that contains all Proto-Vietic cognates reconstructed by Ferlus, retrieved from the Mon-Khmer Languages Project website at sealang.net/monkhmer/database/. This compilation includes data from 20 varieties of eight Vietic languages (cf. Chapter 3). I added the data collected from the three North-Central Vietnamese dialects in the second wordlist to this compilation. Only items with a reflex in standard Vietnamese (Ferlus' *Hanoi Vietnamese*) were kept, which amounts to 673 items. The wordlist is organized by proto-vowel, tone series, and coda types and is given in Appendix AA.

6.2.2 Recording

For the first wordlist, each word was presented to the speakers with a corresponding image on a laptop screen in order to avoid prompts in written or spoken standard Vietnamese. Speakers had to pronounce the target words in the following frame sentence:

Tôi nói ___ thêm một lần.
I say ___ more one time.
'I say the word ___ one more time.'

Each speaker recorded the wordlist four times with different random orderings. The recording sessions took around 20 to 30 minutes per speaker. The data were recorded in a soundproof karaoke room in Cổ Định and Nghi Ân in October 2021 and in a community building in Diêm Điền dialect in November 2021. The recording location in Diêm Điền

was not ideal due to COVID-related sanitary restrictions at that time. The quality of the recordings was affected by echo because the room was empty and had concrete walls, but the data was still good enough for phonetic analysis. A high-quality audio channel was obtained with a Shure Beta53 headset connected to a Steinberg UR242 amplifier. Another audio channel was recorded using a Beyer Dynamics M500 TG microphone as a backup. These two audio signals were recorded simultaneously on a Macbook running the SpeechRecorder application.

The second wordlist was elicited with four speakers (two men, two women) in each of the three dialects, with speakers who had just recorded the first wordlist. Pairs of speakers recorded the second wordlist in the same session, which took around one hour. I read words from the second wordlist to the speakers in standard Vietnamese and asked them to pronounce the dialectal equivalents. They were allowed to discuss multiple equivalents and decide which was the most "authentic" in their dialect[31]. Sometimes the two speakers gave different words, but they were the same most of the time. The recording equipment was the same as for the first wordlist, but different microphones were used for the two speakers. Speakers were compensated for their contribution to the study.

6.2.3 Data processing and statistical modelling

The data from the first wordlist includes 3,712 tokens recorded from speakers of the three dialects, out of which ten tokens were excluded because of mispronunciations. The remaining 3,702 tokens were then annotated in Praat TextGrids using the same conventions as in Arem and Rục data in Chapters 4 and 5. The procedure used to extract and process

[31] Occasionally, one speaker in each pair gave the standardized form of a word instead of the form unique to their dialect. This is a sign of dialect-levelling.

data was also the same as that used for the Arem and Rục data, but I repeat some general points here for convenience.

Relevant acoustic measurements, including f0, H1, H2, A1, A2, CPP, HNR35, F1, and F2, were extracted using PraatSauce (Kirby, 2018) at every 1 ms in the target vowel. The amplitude of different harmonic frequencies, H1, H2, A1, and A2, were formant-corrected (Hawks & Miller, 1995; Iseli & Alwan, 2004) and, therefore, will appear as H1*, H2*, A1*, and A2*. Since the measurement windows were set at 25 ms, measures made at the first and the last 12 ms of the *op* interval (largely coincides with the target vowels) were excluded from the final calculations to avoid factoring in perturbations from adjacent segments.

The data was then z-normalized by speaker, and data cleaning was conducted in two steps on these normalized measures. First, derivatives were obtained for each normalized data point relative to their next consecutive point, and measurements were excluded if they underwent dramatic jumps, i.e., if their derivatives were above or below 0.05 standard deviation (±1 st. dev. for CPP). The thresholds of ±0.05 and ±1 were chosen as a compromise between excluding too much data and leaving too many outliers in the dataset. Dubious values over a longer span were excluded by removing data points above or below three standard deviations of the mean values computed for each combination of *speaker*vowel*tone*. All spectral tilt measurements dependent on excluded f0 and formant values were also removed. In total, the percentage of excluded data is as follows: f0: 14.8%, F1: 6.6%, F2: 7.5%, CPP: 2.7%, HNR35: 13.1%, H1*-H2*: 14.8%.

In this chapter, I use one more phonation indicator than in Chapters 4 and 5; it is HNR35, harmonic to noise ratio measured in a band ranging from zero to 3,500Hz. This

decision was driven by the fact that phonation differences in the tone systems of North-Central dialects were expected to be more complex and, at the same time, subtler than those in the Arem and Rục languages. H1*-H2* and CPP alone cannot fully capture three-way distinctions between modal, breathy, and creaky or tense phonation (Blankenship, 2002; Garellek, 2012; Garellek, 2019) but only suggest a rough division between modal and non-modal phonations. The logic of using HNR35 along with H1*-H2* and CPP is as follows. If a sound, or an interval of a sound, has a higher spectral tilt (higher H1*-H2*, for example) and a lower degree of periodicity (lower CPP and HNR35) than other sounds, then it has a breathier phonation. A sound with a lower degree of periodicity and a lower spectral tilt has a creakier phonation. Modal phonation is considered unmarked in spectral tilts and has a high degree of periodicity. The relative differences between modal, breathy, and creaky phonation are illustrated in Figure 6-5. For more details on the acoustic differences between phonation types, readers are referred to Garellek (2019).

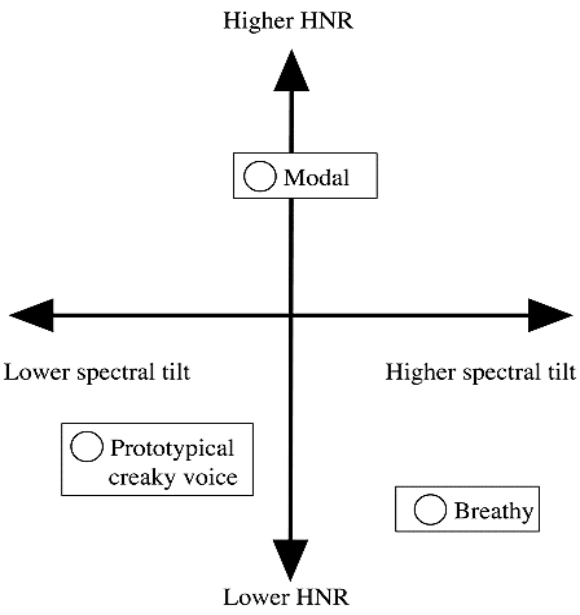


Figure 6-5. Relative acoustic differences between modal, breathy, and creaky phonation (Garellek 2019: 90).

As we will see in the results section, the tones in the three North-Central Vietnamese dialects are well-distinguished by large differences in f0 height, f0 contour, duration, phonation, and vowel quality, although the two last properties are less consistent and more dialect-specific. Therefore, I will only perform statistical analyses where needed, namely, to confirm observations made in previous studies or my initial auditory assessments of tone mergers and vowel quality differences.

To facilitate statistical comparisons, vowel duration was normalized to 100 equidistant intervals, and acoustic measurements were averaged accordingly. Generalized additive mixed models (GAMMs) were fitted to f0 and H1*-H2* of the seemingly merged tone pairs using the *mgcv* package (Wood & Wood, 2015) in R (RCoreTeam, 2013). The interaction between *tone* and *vowel* was included as a fixed factor and a smooth term in the models. Random effects were accounted for by including random smooths for *word* and *speaker*, the latter was further divided by combinations of *tone*vowel*. The models were also refined by handling autocorrelation issues (Baayen et al., 2018) and scattered *t*-distribution of residuals (Wood, 2006; Wieling, 2018; Soskuthy, 2020). GAMMs will also be fitted to formant data, F1 and F2, of the three dialects to inspect possible tone-conditioned vowel differences. The model structure is as follows:

```
f0 | H1*-H2* | F1 | F2  ~ Tone_Vowel + s(Time, by = Tone_Vowel) +
                          s(Time, Word, bs="fs", m=1) +
                          s(Time, Subject, by = Tone_Vowel, bs="fs", m=1), data=…, rho=…,
                          AR.start=…$start.event, family= "scat")
```

In the graphs representing the GAMM-predicted acoustic values of each tone pair, two tones are said to statistically differ from each other if their trajectories and the ribbons

representing a 95% confidence interval do not overlap at any time interval. Alternatively, if the difference between the two categories is presented instead, it is said to significantly differ from 0 when the trajectory and its ribbon do not touch the x-axis at y = 0.

In time-sensitive graphical representations of observed values, time was normalized to reflect duration differences between tones by multiplying the 100-interval scaled time by the grand mean duration of each tone. The raw duration of tones in each dialect was tested for the effect of *tone* by fitting it to generalized linear mixed models. In these models, *tone duration* is the dependent variable, fixed factors include *tone, vowel*, and their two-way interaction, and random effects include random intercepts for *subject* and *word*. I attempted to simplify models using the method used in Chapters 4 and 5, but the optimal models were always the complete ones.

```
ToneDuration ~ Tone*Vowel + (1|Subject) + (1|Word)
```

The recordings of the second wordlist will not be analyzed and reported acoustically. Instead, I listened to them and transcribed the words as pronounced by speakers. If there were multiple variants, I used the most common one. These data were integrated into the third wordlist (based on Ferlus' Proto-Vietic reconstructions) to explore vowel changes in Vietic languages.

The 673 cognate sets of the third wordlist were ordered by proto-vowel, tone series, and coda types. Initially, the tone series (high or low) of a proto-form was identified automatically based on its proto-onset: the high series was conditioned by all onset obstruents other than voiced stops. The series of proto-forms with sonorant onsets (nasal, lateral) or consonant clusters, e.g. *pr, pl, bl, br,…* (cf. Chapter 3), were considered neutral.

I then revised this initial assignment by changing the series according to whether the standard Vietnamese reflex has a high-series (A1, B1, C1, or D1) or a low-series tone (A2, B2, C2, or D2). This two-step assignment strategy is necessary since tonal/registral disharmonies are attested between Vietnamese and other Vietic languages (Ferlus, 1999 and c.f. Chapter 2). Because I aim to determine if vowel changes in standard Northern Vietnamese compared to Proto-Vietic are register-conditioned, it is logical to assign series as reflected in the modern language. Then, cases of vowel change from Proto-Vietic to standard Vietnamese were counted and grouped by register/series and coda type to see if these two factors could have conditioned them.

6.3 The phonetics of tone systems in North-Central Vietnamese dialects

This section presents acoustic analyses of the tone systems of three North-Central Vietnamese dialects: Cổ Định (Thanh Hoá province), Nghi Ân (Nghệ An province), and Diêm Điền (Quảng Bình province). For each dialect, I first try to determine whether some tones found in standard Vietnamese are merged or undifferentiated, as reported in previous studies. Then, data on the fundamental frequency, f0, and phonation, H1*-H2*, CPP, and HNR35, of each tone system are presented. I finally present data on tone duration and tone-conditioned vowel variability.

6.3.1 The Cổ Định dialect (Thanh Hoá province)

6.3.1.1 The confusion of C1 and C2 tones

As discussed above, we expect C1 and C2 to be identical in Cổ Định, like in other Thanh Hoá dialects. Separate GAMMs were fitted to the f0 and H1*-H2* data of C1 and C2 in order to determine if these two tones are significantly different from each other. The model predictions are provided below in Figure 6-6.

In the upper panel of Figure 6-6, we can see that the predicted f0 of C1 and C2 are almost identical throughout the duration of the three vowels /iː, ɛː, aː/, as shown by their overlapping lines and ribbons. The f0 difference at tone onsets in the vowel /uː/ is likely due to intrinsic vowel f0: the vowel is diphthongized in the word /muː^{C2}/ > [mɤw^{C2}] 'hat.' In the lower panel of Figure 6-6, the GAMM-predicted H1*-H2* of these two tones show no significant difference. Therefore, it can be safely confirmed that C1 and C2 are identical in Cổ Định, and I will refer to them collectively as C1-C2 and treat them as a single category in subsequent sections.

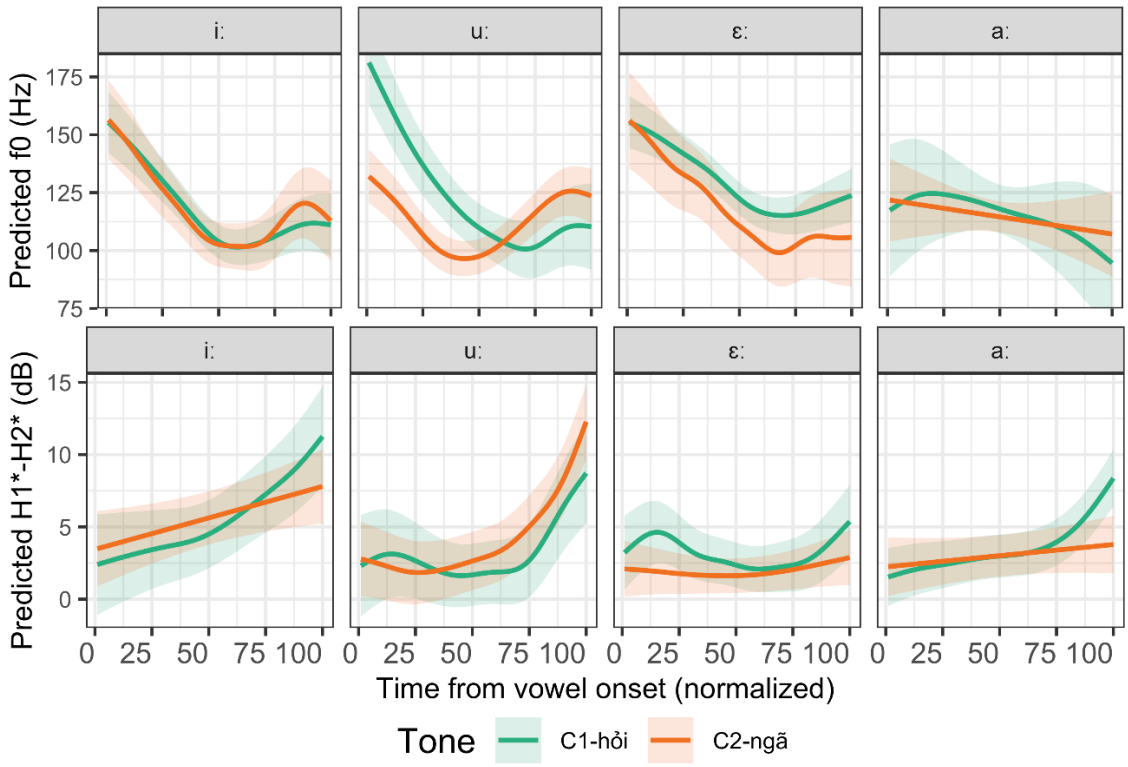


Figure 6-6. GAMM-predicted f0 (upper) and H1*-H2* (lower) of C1 and C2 tones of the Cổ Định dialect, by *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons overlap, the difference between categories is not significant.

6.3.1.2 f0 and phonation type

Figure 6-7 shows the trajectories of f0 and three different measurements of phonation type, H1*-H2*, CPP, and HNR35, in the tones of the Cổ Định dialect.

Let us first consider the f0 results in the top-left panel in Figure 6-7. Tones are clearly differentiated by f0 height, f0 contour, and duration. A1 is overall higher than A2, but they are both falling, although the falling contour is less steep in A1. B1 and B2 start at roughly the same height and then rise and fall, respectively. C1-C2 has the overall lowest f0 of all tones. Its contour is falling-rising, with the rising offset not reaching the height of its onset. The two checked tones, D1 and D2, are more than twice as short as the other tones. Their contours are similar to those found with B1 and B2, but D1 is at the top of the

f0 range, distinct from all other tones. Individual variation in the realization of Cổ Định tones is reported in Appendix 6-2. Variation between individuals is found, but the relative f0 height, f0 contour, and duration of their tones follow the general patterns described above.

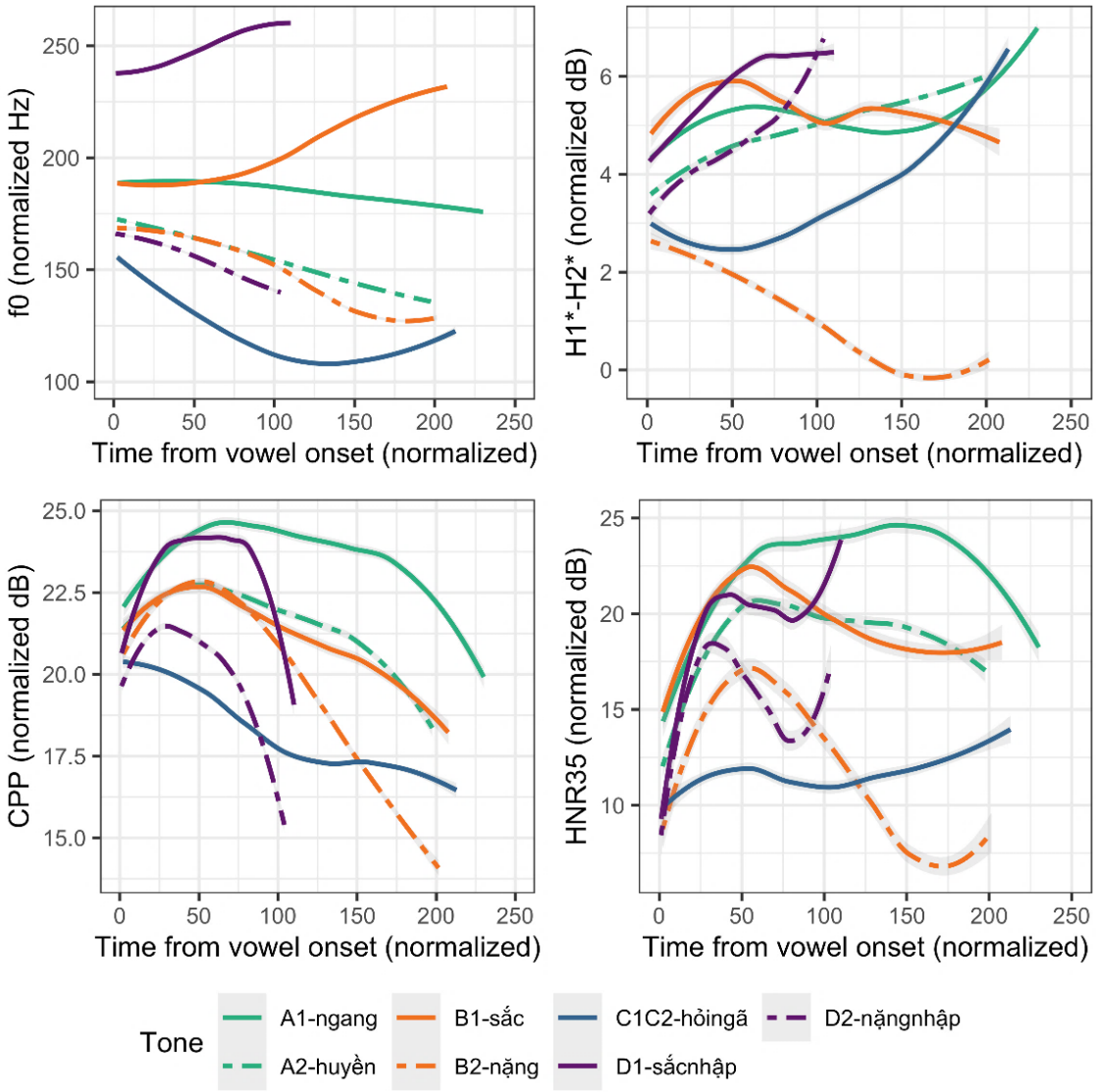


Figure 6-7. f0, H1*-H2*, CPP, and HNR35 trajectories of Cổ Định tones (top to bottom, left to right).

We now turn to phonation type. A1 has a higher H1*-H2* than its low-series counterpart A2 over the first half of its articulation, but the pattern reverses in its second

half (top-right panel in Figure 6-7). However, A1 has a consistently higher CPP and HNR35 than A2 (bottom-right and bottom-left panels). This indicates that A1 has a modal phonation (higher spectral tilt and less noise), and A2 has a tenser/creakier phonation. By the same logic, the results also show that B2 and D2 have a tenser/creakier phonation than their high-series counterparts, B1 and D1, respectively. C1-C2 patterns with the three low-series tones, A2, B2, and D2, in having an overall tense/creaky phonation.

Other patterns are worth noting. The offsets of the two checked tones, D1 and D2, have a higher H1*-H2* but a lower CPP and HNR35 than A1. This indicates that D1 and D2 culminate with a breathier phonation, but this phonation is likely due to the opening of the glottis in anticipation of the following coda stops. In addition, B1 ends on a lower H1*-H2*, CPP, and HNR than A1. I interpret these patterns as evidence that B1 has a tenser phonation towards its offset as it reaches its highest f0.

Overall, the tone system of the Cổ Định dialect makes a phonation difference between modal high-series tones, A1, B1, and D1, and tenser/creakier low-series tones, A2, B2, D2, and C1-C2 tone. This phonation difference is correlated with the overall f0 level of these two groups of tone: tones with lower f0 are tenser/creakier than those with higher f0. Tense phonation is also found in the high f0 offset of B1. However, when looking at spectrograms, creaky phonation is only noticeable at the offset of tones B2 and C1-C2, as exemplified in Figure 6-8 and Figure 6-9, suggesting that A2, D2, and B1 are merely tense. This final creaky phonation in B2 and C1-C2 is realized consistently across speakers.

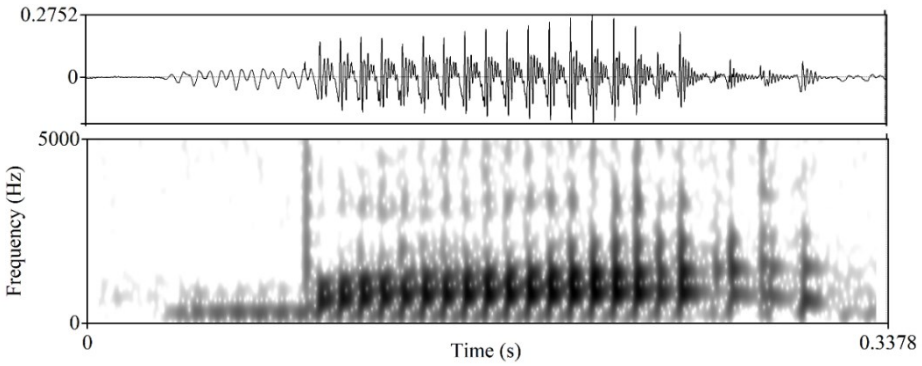


Figure 6-8. Oscillogram and spectrogram of syllable [ɓaː^{B2}], pronounced by a 61-year-old male speaker in the Cổ Định dialect. The syllable has a strong creaky phonation at its offset.

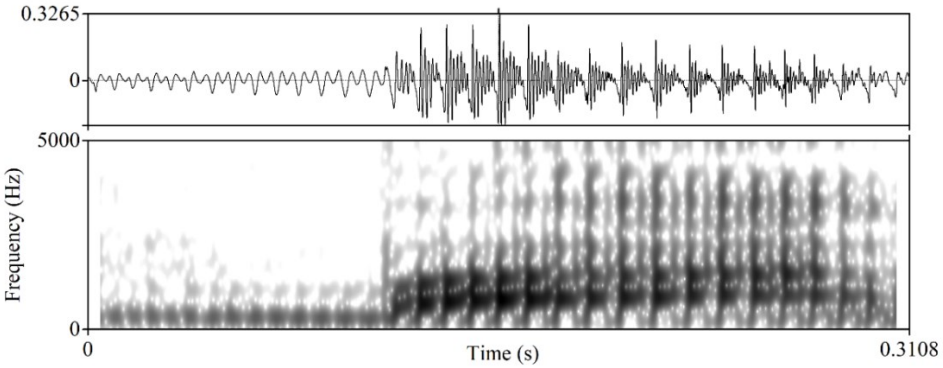


Figure 6-9. Oscillogram and spectrogram of syllable [ɓaː$^{C1\text{-}C2}$], pronounced by a 61-year-old male speaker in the Cổ Định dialect. The syllable gradually develops a tense/creaky phonation toward its end.

The H1*-H2*, CPP, and HNR35 results for individual speakers are provided in Appendices 6-3, 6-4, and 6-5, and they generally follow the patterns that have just been described.

6.3.1.3 Duration

The duration distribution of Cổ Định tones grouped by vowel is given in Figure 6-10. The results of the optimal generalized linear mixed (GLM) model fitted to the duration data are provided in Appendix 6-6.

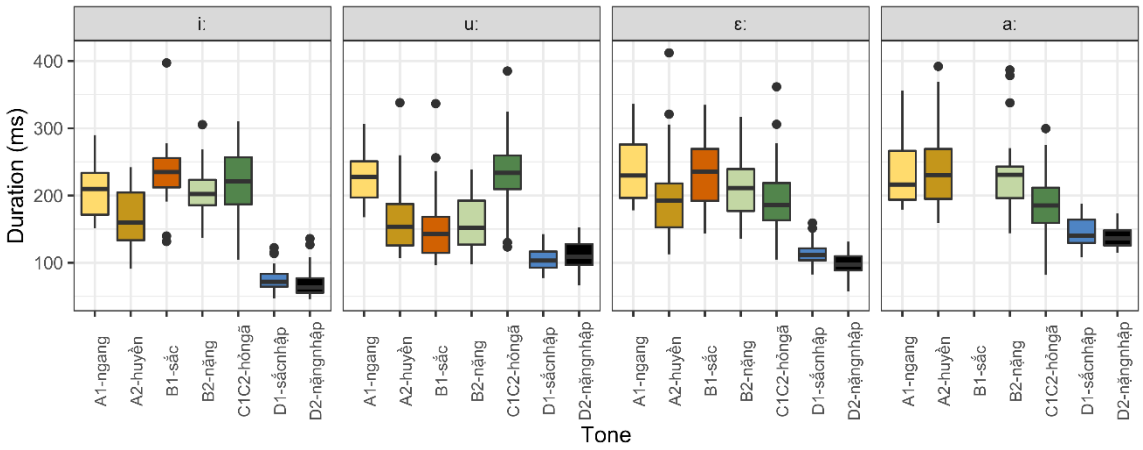


Figure 6-10. Duration of Cổ Định tones, by *vowel*.

Unsurprisingly, the two checked tones, D1 and D2, are significantly shorter than all other tones. Some interactions between vowels and tones are also significant (Appendix 6-6), but these effects are complex and do not condition consistent patterns of contrast between tones, as can be seen in Figure 6-10.

6.3.1.4 Vowel quality

The F1 and F2 of four vowels /iː, uː, ɛː, aː/ grouped by tone categories and tone series are shown in Figure 6-11. The GAMM-predicted F1 and F2 differences between high- and low-series vowels are given in Figure 6-12. Some patterns of vowel changes conditioned by tone series are visible, but these changes are vowel-specific and do not apply equally to all tone categories.

The vowel /ɛː/ is realized as [ʲɛː] in both series, but the low-series /ɛː/ is more open in the A and B categories (higher F1) and more closed in the D category (lower F1). This is confirmed by the significant F1 differences in the model prediction in Figure 6-12 (the three upper rows of the third column from the left), by which the difference is negative in

the A and B categories and positive in the C category, respectively.

The closed vowel /uː/ is realized as [ᵊuː] in both series, but does not show much difference between the high and low series in any of the three tone categories, A, B, and D, except for a negligible difference at the end of D category (three upper rows of the second column from the left in Figure 6-12).

Low-series /iː/ is realized as a rising diphthong [ᵉiː] in the B category but not in the A category. Like the vowel /ɛː/, the low-series /iː/ is also more closed in the D category. These patterns are confirmed by the predicted F1 differences in Figure 6-12 (three upper rows of the first column from the left). For the vowel /aː/, there is no vowel quality difference between the high- and low-series tones in either F1 or F2.

For all vowels and tone categories, F2 does not vary much between low- and high-series tones, as shown by the absence of significant effects in most cells of the three lower rows in Figure 6-12. The only exception is the lower F2 of the vowel /iː/ in tone B2 since it is realized as the rising diphthong [ᵉiː].

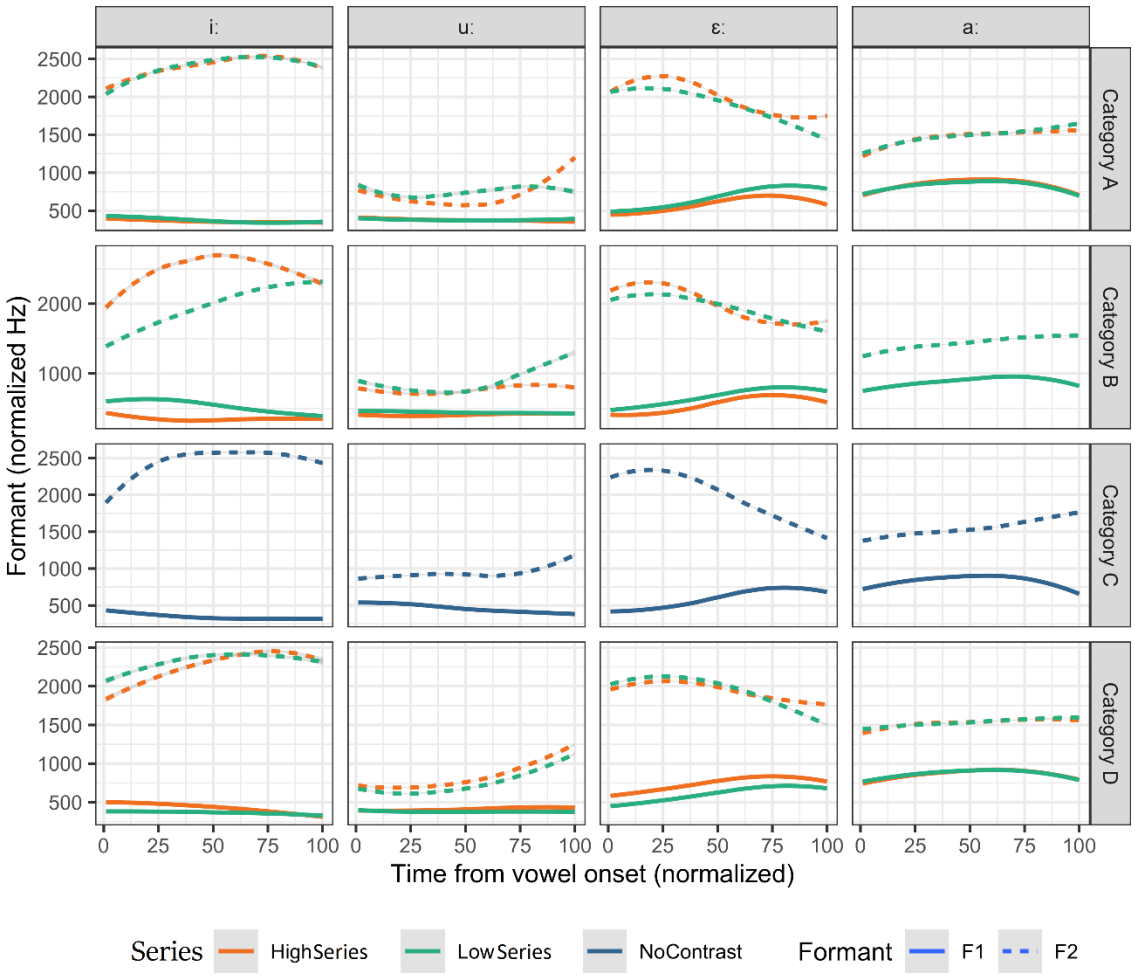


Figure 6-11. F1 and F2 trajectories of four vowels /iː, uː, ɛː, aː/ in the Cổ Định dialect by *tone category* and *series*.

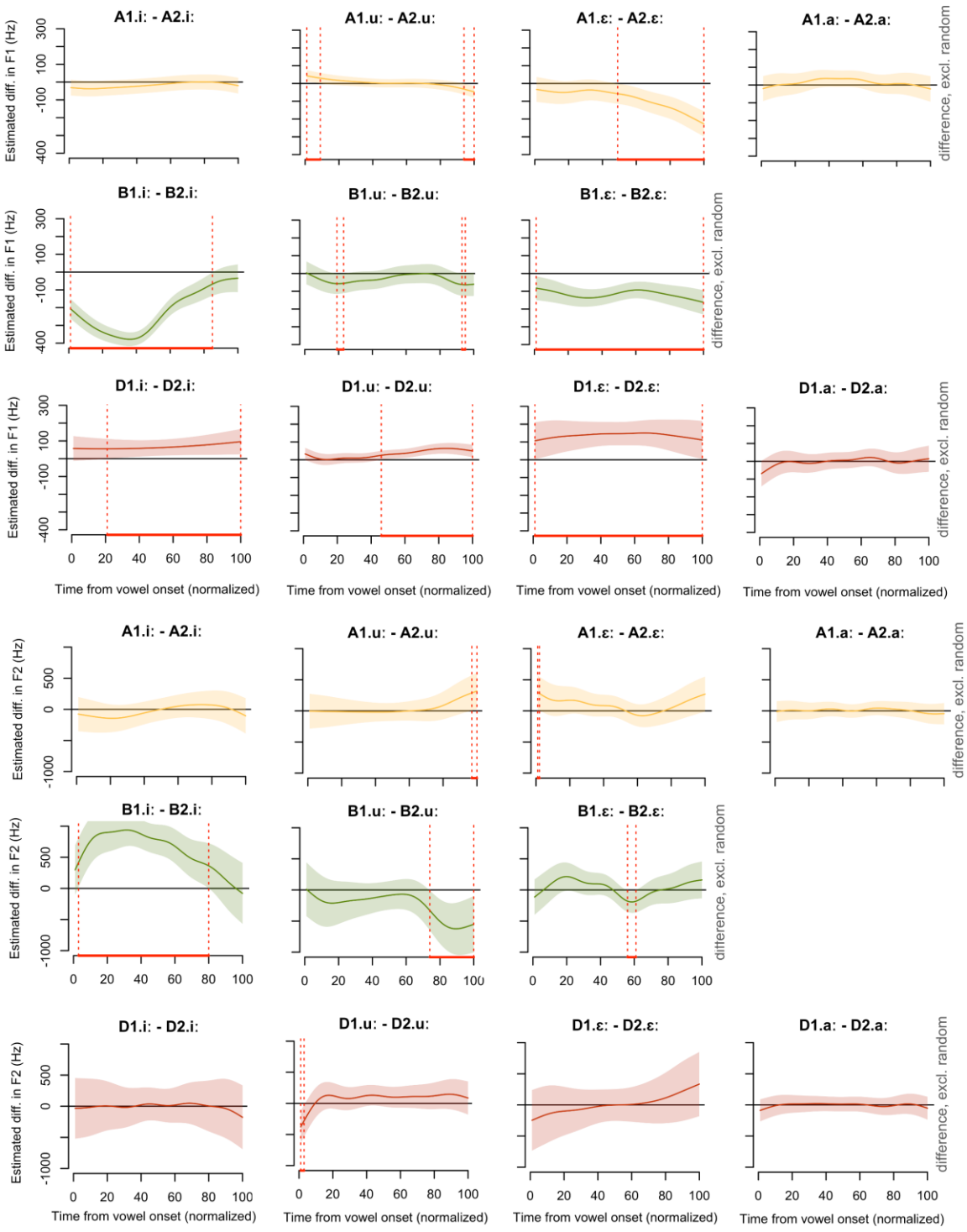


Figure 6-12. GAMM-predicted F1 (three upper rows) and F2 (three lower rows) difference between high- and low-series vowels in Cổ Định by *tone category* and *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons do not touch the horizontal line at y = 0, the difference is significant. Vertical dotted red lines and a red bar on the x-axis further mark significant intervals.

In short, in Cổ Định, vowels are marginally more open in the low-series tones A2 and B2, but the pattern is reversed in the D category. It is, therefore, difficult to attribute these limited variations in vowel quality to a former register contrast.

The phonetic realization of Cổ Định tones and their historical sources are summarized in the following Table 6-10[32].

Table 6-10. Tone system of the Cổ Định (Thanh Hoá) dialect. C1 and C2 tones are phonetically identical. The creaky phonation at offsets of B2 and C1-C2 tones are marked by the IPA symbol for creakiness (˷) under the phonetic values of these tones.

	A category (open)	*B category (*-ʔ)*	*C category (*-h)*	*D category (checked)*
Series 1 (High register or voiceless onsets)	44	45	31̰2	45 + stop traces of opening diphthongization
Series 2 (Low register or voiced onsets)	32 (tense) traces of opening diphthongization	42̰ traces of opening diphthongization		32 + stop (tense)

6.3.2 The Nghi Ân dialect (Nghệ An province)

6.3.2.1 The merger of B1 and C1 tones, and B2 and C2 tones

In order to see if B1 is phonetically distinct from C1 and B2 from C2, two GAMMs were fitted to the f0 and H1*-H2* data of these two pairs of tones, whose predictions are plotted in Figure 6-13.

Figure 6-13 shows no consistent GAMM-predicted f0 differences between B1 and C1 (top-left panel) and B2 and C2 (bottom-left panel). For example, f0 is higher in B2 than C2 in vowels /iː, uː/, but the pattern is reversed in vowels /ɛː, aː/. Neither tone pair shows

[32] F0 of D1 tone is exceptionally higher than all other tones, but because it and its low-register counterpart D2 can be considered as forming a subsystem of the tone system of Cổ Định, the highest f0 point of the rising tone B1 is taken as the convientional highest pitch (5) in Chao (1930)'s numeric tonal conventions.

a significant GAMM-predicted H1*-H2* discrepancy (right panels). Therefore, B1 and C1, and B2 and C2 are phonetically indistinct and will be collectively referred to and analyzed as B1-C1 and B2-C2. This confirms that the Nghi Ân dialect only has four tones (Võ, 1993; Lê, 2003).

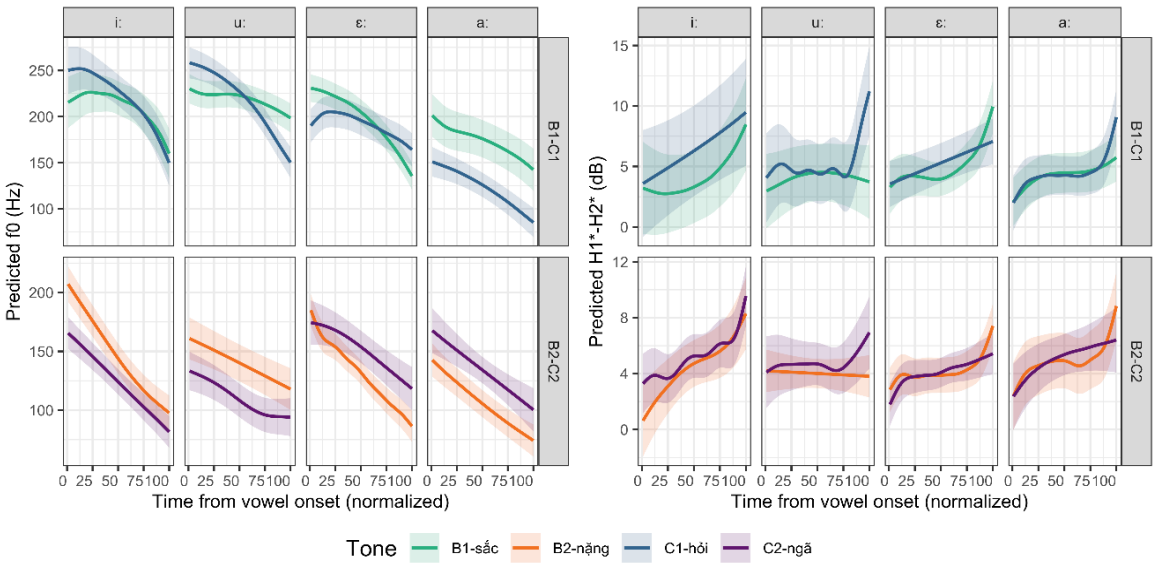


Figure 6-13. GAMM-predicted f0 (left) and H1*-H2* (right) data of B1 and C1 (upper) and B2 and C2 (lower) tones of the Nghi Ân dialect, by *vowel*. The ribbons represent 95% confidence interval. At any time point, if the ribbons overlap, the difference between categories is not significant.

6.3.2.2 f0 and phonation

The f0, H1*-H2*, CPP, and HNR35 trajectories of Nghi Ân tones are given in Figure 6-14. Looking at f0 results (top-left panel) first, one can note that there is a distinct grouping between the high-series tones A1, B1-C1, and D1 and the low-series tones A2, B2-C2, and D2: their f0 ranges do not overlap. In addition, the contours of tone pairs in the same category are roughly the same in the two series: overall level tones A1 and A2, falling tones B1-C1 and B2-C2, and short falling tones D1 and D2.

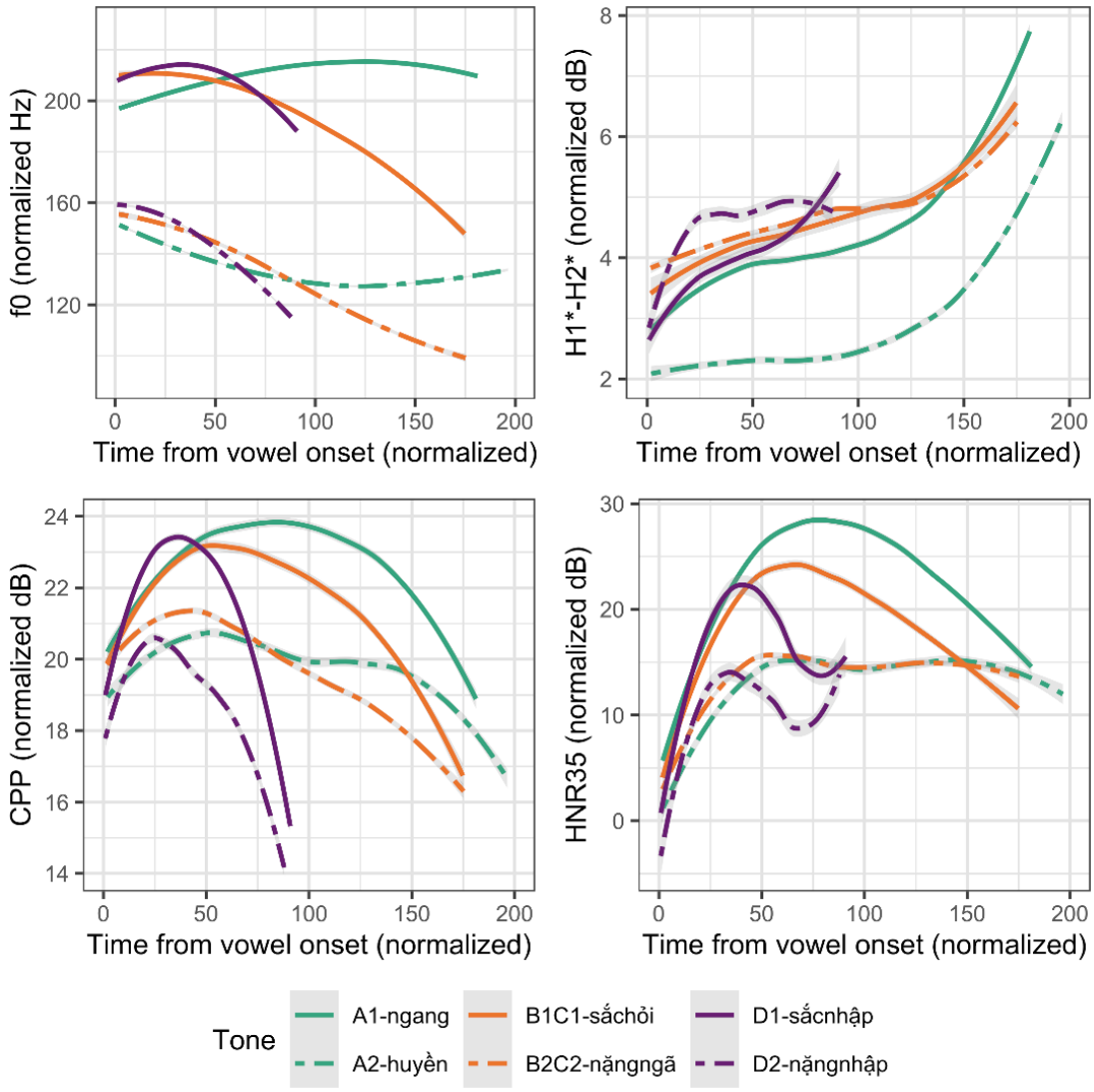


Figure 6-14. f0, H1*-H2*, CPP, and HNR35 trajectories of the Nghi Ân tones (top to bottom, left to right).

H1*-H2* (top-right panel) does not clearly distinguish the tones of the two series, except in the A series, which does present this contrast due to the very low H1*-H2* of A2. The CPP and HNR35 values of high-series tones A1, B1-C1, and D1 are all greater than those of their low-series counterparts, A2, B2-C2, and D2. These patterns suggest that the group of low-series tones has a tenser/creakier phonation than that of high-series tones. The phonation at the offsets of D1 and D2 tones are individually variable (Appendix 6-7

to 6-10) but not as consistent as what was found in the Cổ Định dialect.

There seems to be a correlation between f0 height and phonation in Nghi Ân: tones in the low f0 range (low-series) have a tenser/creakier phonation than tones in the high f0 range (high-series). In other words, in this dialect, phonation seems to be conditioned by f0 height. However, this phonation difference is neither audible nor visible on spectrograms, suggesting mere tenseness rather than actual creakiness. The tenser voice found in low series Nghi Ân tones is a rare example of a tense voice associated with a low f0 since it has been cross-linguistically observed that tense, or "pressed" voice is usually high in f0 (Dawson, Garellek, López-Francisco, & Amith, 2022). Whether this tenseness plays a role in tone perception is to be answered in future studies. The f0, H1*-H2*, CPP, and HNR35 results of individual speakers are provided in Appendices 6-7 to 6-10. Despite the individual variation, the general tone patterns that have just been described hold.

6.3.2.3 Duration

The distribution of tone (vowel) duration in the Nghi Ân dialect, subset by *vowel*, is given in Figure 6-15. The summary of the optimal linear mixed model fitted to the duration data is provided in Appendix 6-11.

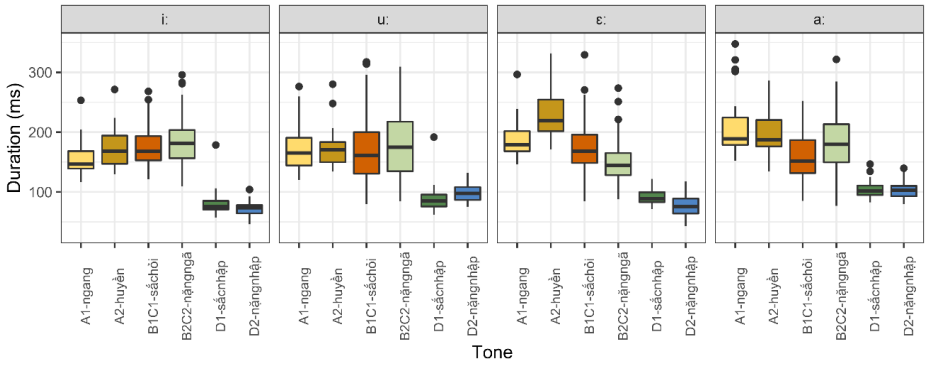


Figure 6-15. Duration of Nghi Ân tones, by *vowel*.

The only consistent and significant pattern observed is the short duration of the two checked tones, D1 and D2, which is about half of the other tones. Some interactions between tones and vowels are significant (Appendix 6-11) but do not result in any other consistent duration difference pattern between tones.

6.3.2.4 Vowel quality

The normalized F1 and F2 of four vowels, /iː, uː, ɛː, aː/, as pronounced in the Nghi Ân dialect, divided by *tone category* and *tone series*, are given in Figure 6-16. The GAMM-predicted F1 and F2 differences between high- and low-series vowels are given in Figure 6-17. We can observe clearer and more consistent series-conditioned vowel variations in Nghi Ân than in Cổ Định.

The front close vowel /iː/ shows a clear rising diphthongization in the low series in A and B-C categories (recall that B1 and C1, and B2 and C2 merged), as evidenced by a higher and falling F1 and a lower and rising F2 in the low series. These formant differences are significant (the first column in Figure 6-17). The vowel /iː/ is realized as [^{e}iː] in these low-series contexts. It is also slightly more open in the low-series tone D2 than in its high-series counterpart D1. This fact is evidenced by a higher F1 in Figure 6-16 and the significantly negative difference from the two-thirds mark of the vowel's timecourse (the top-down third cell of the first column in Figure 6-17. However, the F2 discrepancy between D1 and D2 is not significant.

The back close vowel /uː/ is also more open in the low-series tones A2, B2-C2, and D2, although its F2 does not significantly vary between the low- and high-series, indicating an absence of vowel fronting (the second column of Figure 6-17). Puzzling enough, these vowel changes in the two close vowels /iː, uː/ are the opposite of what is found in other

Austroasiatic register languages, as they are conditioned by the low series instead of the high one.

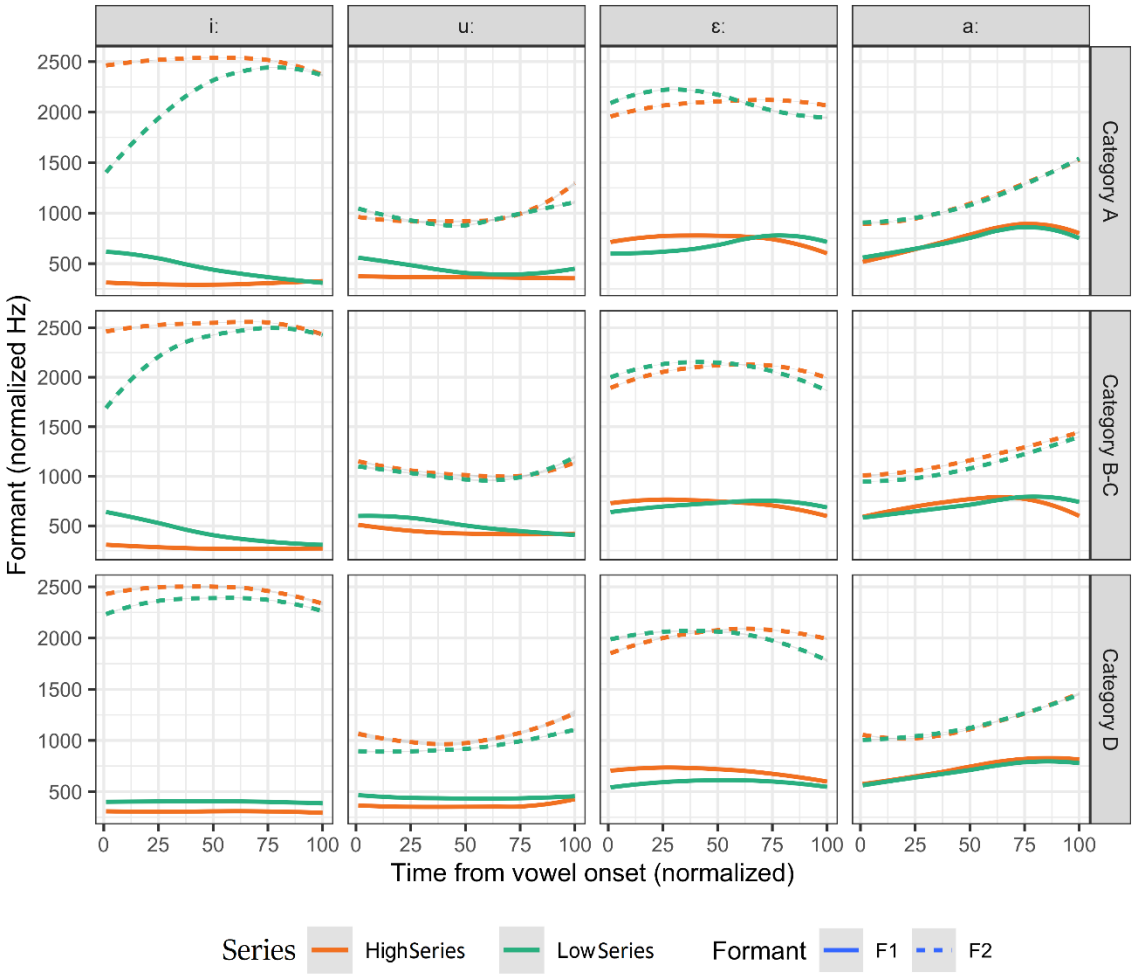


Figure 6-16. Normalized F1 and F2 trajectories of four vowel /iː uː ɛː aː/ in the Nghi Ân dialect by *tone category* and *series*.

In its first half, the mid-open vowel /ɛː/ has a significantly lower F1 in the low series than in the high one in all three tone categories, indicating that the vowel is slightly more closed in the low series. Its F2 does not vary to a great extent between the two series (the third column in Figure 6-17). The vowel /aː/ does not show any formant partition between the low and high series, but its F1 and F2 trajectories indicate that it uniformly became a complex rounded-back vowel [ɑ^{a}]. Alves (2007) described this vowel change as resulting in

the simple [ɔː].

There is, therefore, good evidence of vowel quality differences conditioned by tone series in Nghi ân, but they do not seem to match what is typically found in register systems in that the low series is associated with falling diphthongs. In Section 6.4.1, I will provide more vowel correspondences between the three North-Central and standard Northern dialects and show that close and open-mid vowels of the Nghi Ân dialects have more open (or rising) diphthongs in the low series.

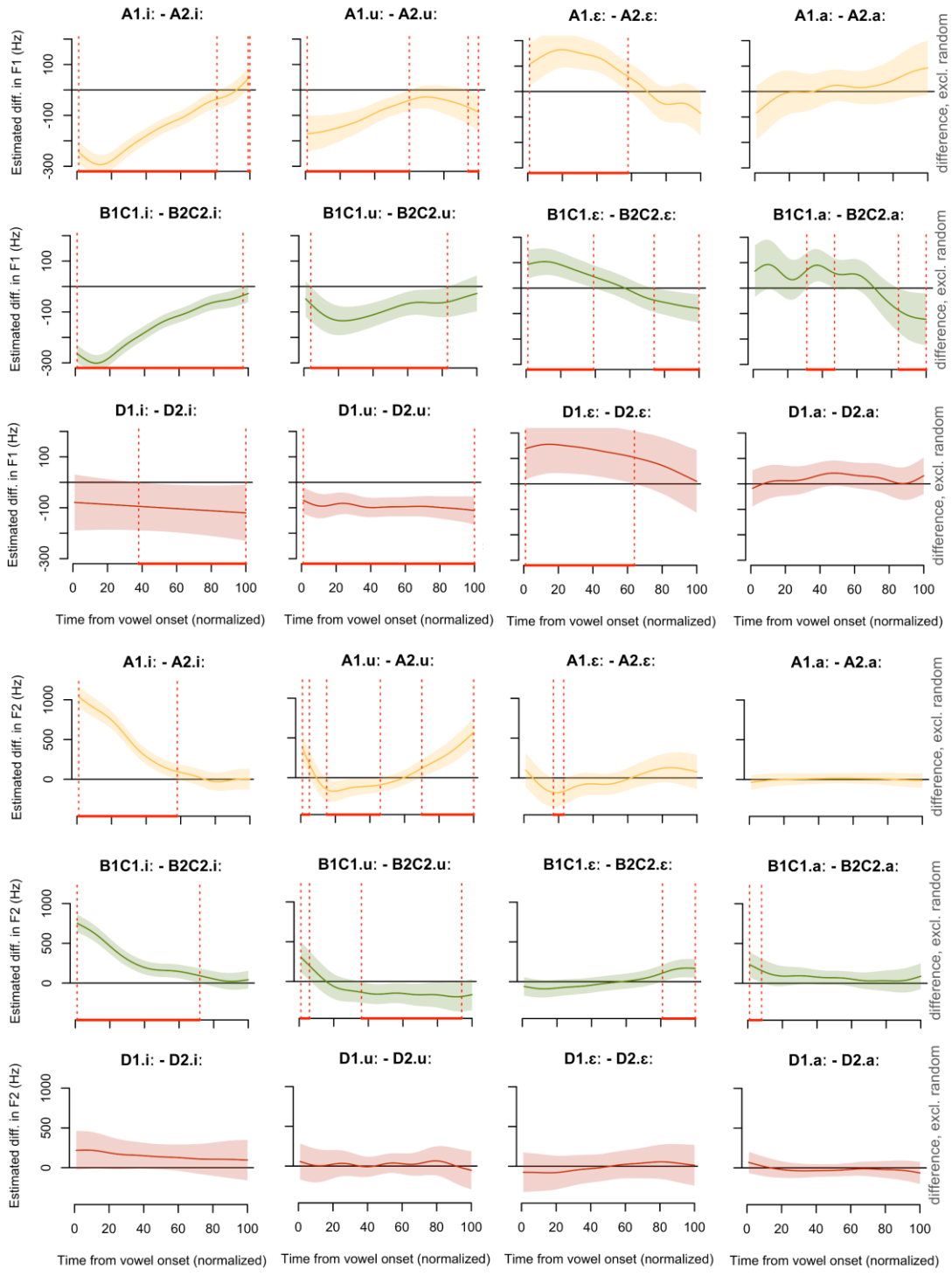


Figure 6-17. GAMM-predicted F1 (three upper rows) and F2 (three lower rows) difference between high- and low-series vowels in Nghi Ân by *tone category* and *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons do not touch the horizontal line at y = 0, the difference is significant. Vertical dotted red lines and a red bar on the x-axis further mark significant intervals.

The phonetic realization of the Nghi Ân tones is summarized in Table 6-11.

Table 6-11. Tone system of the Nghi Ân (Nghệ An) dialect. Two pairs of tones, B1 vs. C1 and B2 vs. C2, are merged.

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*	*D category (checked)*
Series 1 (High register or voiceless onsets)	55	53		54 + stop
Series 2 (Low register or voiced onsets)	33 (tense) opening diphthongization of close and open-mid vowels	31 (tense) opening diphthongization of close and open-mid vowels		32 + stop (tense) opening diphthongization of close and open-mid vowels

6.3.3 The Diêm Điền dialect (Quảng Bình province)

6.3.3.1 The merger of C1 and C2 tones

Speakers of the Diêm Điền dialect explicitly say that C1 and C2 pronunciation is difficult and that they cannot distinguish these two tones. In order to see if there is a merger between C1 and C2 tones in the dialect, two GAMMs were fitted to the f0 and H1*-H2* data of these two tones. These GAMMs have the same structure as those in sections 6.3.1 and 6.3.2 on tone merging in Cổ Định and Nghi Ân. Predictions of these models are plotted in Figure 6-18.

For the four vowel contexts, the GAMM-predicted f0 and H1*-H2* of C1 and C2 tones show no significant differences, as evidenced by their overlapping trajectories and confidence intervals (ribbons). Therefore, in the following sections, I treat these two tones as single-tone C1-C2.

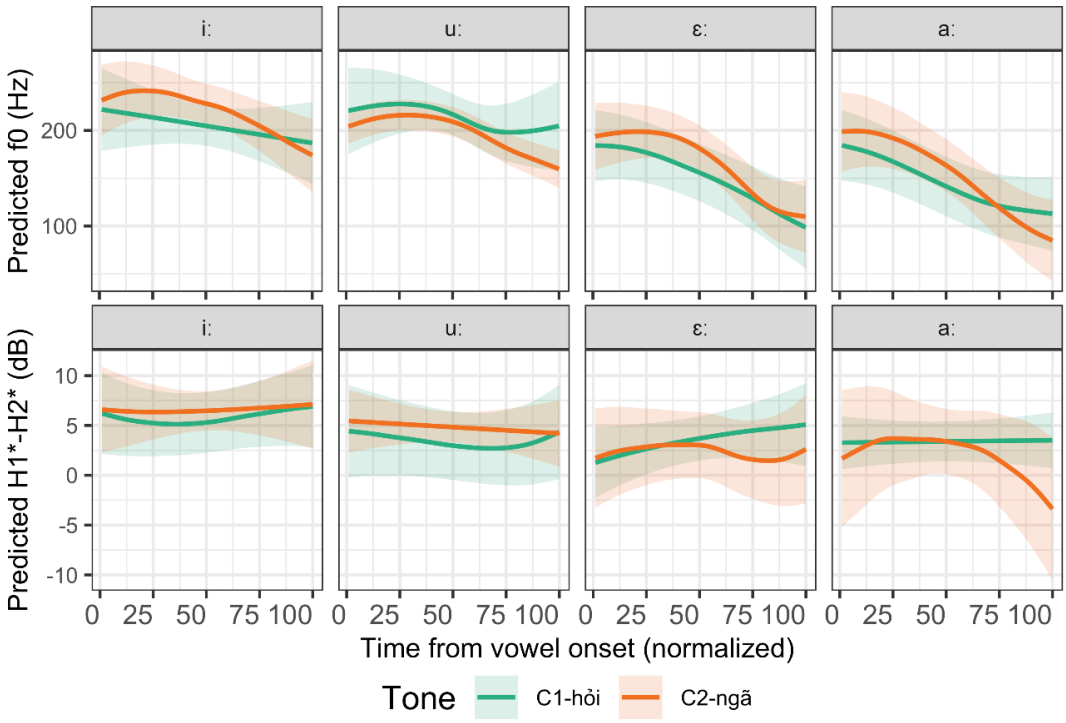


Figure 6-18. GAMM-predicted f0 (upper) and H1*-H2* (lower) of C1 and C2 tones of the Diêm Điền dialect, by *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons overlap, the difference between categories is not significant.

6.3.3.2 f0 and phonation

The f0, H1*-H2*, CPP, and HNR35 trajectories of the tones of the Diêm Điền dialect are given in Figure 6-19. These tones are distinguished in terms of f0 height, f0 contour, duration, and phonation type.

The f0 of Diêm Điền tones (top-left panel in Figure 6-19) shows the opposite pattern to most Vietnamese tone systems: high-series tones have an overall lower f0 than their low-series counterparts: A2 is a high-level tone, A1 is a mid-level tone (it is, in fact, slightly falling); B2 is a mid-falling tone, B1 is a low-rising tone; D2 and D1 tones have the same f0 contours as B2 and B1, but they are only half as long. C1-C2 is an overall high-falling tone with the highest f0 onset. Although variations in f0 trajectories are observed between individuals (Appendix 6-12), all speakers follow these general patterns.

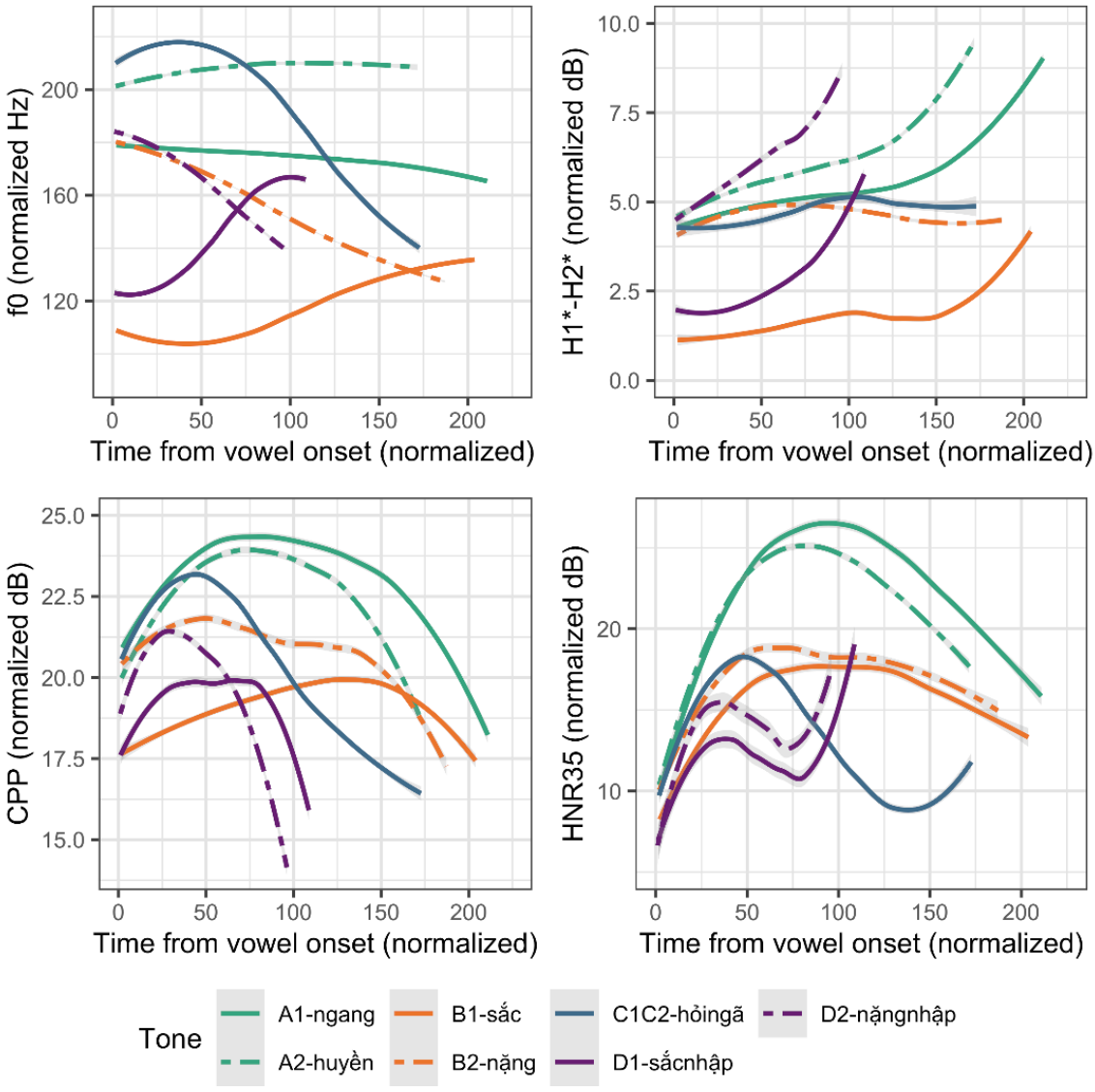


Figure 6-19. f0, H1*-H2*, CPP, and HNR35 trajectories of Diêm Điền tones (top to bottom, left to right).

The two tones with the overall lowest f0, B1 and D1, also have the lowest H1*-H2* values (top-right panel in Figure 6-19). They also have lower CPP and HNR35 (bottom panels) than their low-series counterparts, B2 and D2. This indicates that B1 and D1 have a tenser/creakier phonation than their low-series counterparts, B2 and D2. B2 and C1-C2 have a tenser/creakier phonation than A1 and A2, as suggested by their lower H1*-H2*, CPP, and HNR35. In fact, a typical creaky phonation is evident at the offsets of the

mid-falling B2 and high-falling C1-C2, as exemplified in Figure 6-20 and Figure 6-21, respectively.

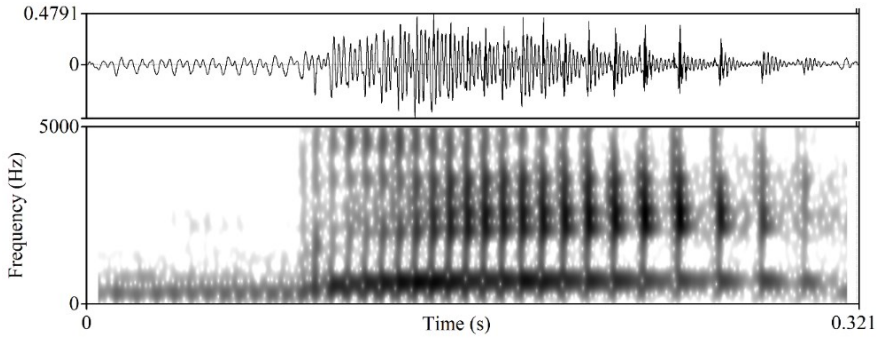


Figure 6-20. Oscillogram and spectrogram of syllable [ɓɛː^{B2}], pronounced by a 90-year-old male speaker in Diêm Điền. The syllable has a strong creaky phonation at its offset.

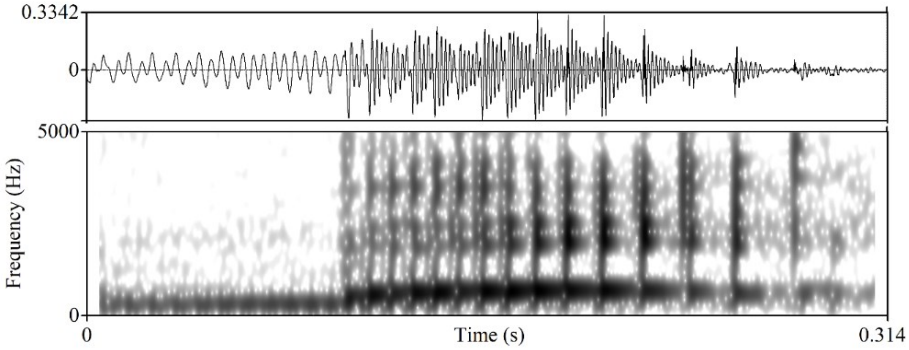


Figure 6-21. Oscillogram and spectrogram of syllable [ɓɛː$^{C1-C2}$], pronounced by a 90-year-old male speaker in Diêm Điền. The syllable has a strong creaky phonation at its offset.

Interestingly, the high-level tone A2 has a higher H1*-H2* and a lower HNR35 than the mid-level A1 tone, suggesting that the A2 is breathier than A1, even if it has a higher f0. Examples of the phonation differences between these two tones are given in Figure 6-22. The significance of this finding for Vietnamese tonogenesis will be discussed in Section 6.5.

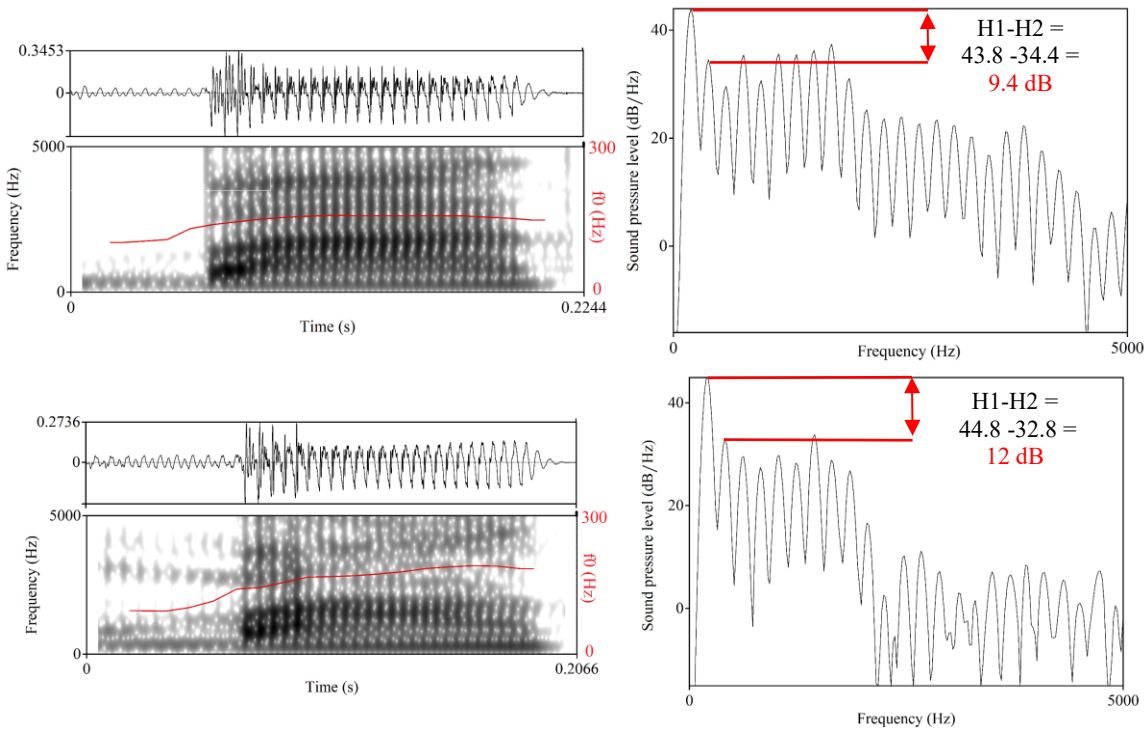


Figure 6-22. Oscillogram, spectrogram, and spectra of syllables [ɓaːA1] (upper) and [ɓaːA2] (lower), pronounced by a 62-year-old female speaker of the Diêm Điền dialect. The spectra are calculated over a 40-ms window in the middle of the two tones. The A2 tone shows a higher spectral tilt (breathier) and a higher f0 than the A1 tone. The breathy phonation of the A2 tone is evidenced by the low energy in the range of high frequencies and a higher H1-H2.

6.3.3.3 Duration

The distribution of tone (vowel) duration in the Diêm Điền dialect is illustrated in Figure 6-23. The results of the optimal generalized linear mixed model fitted to the duration data are given in Appendix 6-16. Again, the only consistent and significant pattern is the short duration of the two checked tones, D1 and D2, compared to those of other tones. Interactions between tones and vowels are complex and do not result in consistent duration differences across different vowel contexts.

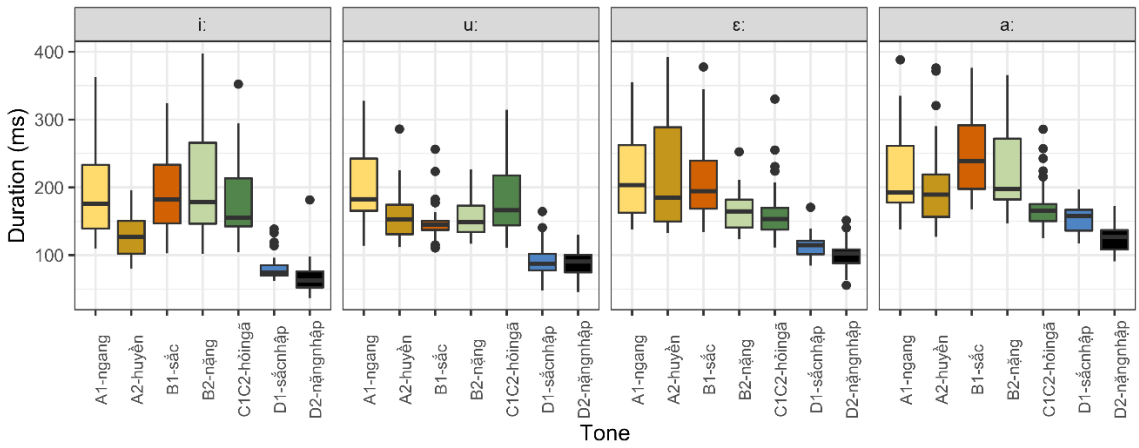


Figure 6-23. Duration of Diêm Điền tones, by *vowel*.

6.3.3.4 Vowel quality

Figure 6-24 shows F1 and F2 trajectories of the four vowels /iː, uː, ɛː, aː/ in the Diêm Điền dialect subgrouped by *tone category* and *series*. Vowel quality is consistent across contexts and does not exhibit any series-conditioned variation. This absence of series-conditioned vowel quality in Diêm Điền is further confirmed by the lack of consistently significant F1 and F2 differences between the low- and high-series tones in the model prediction provided in Figure 6-25.

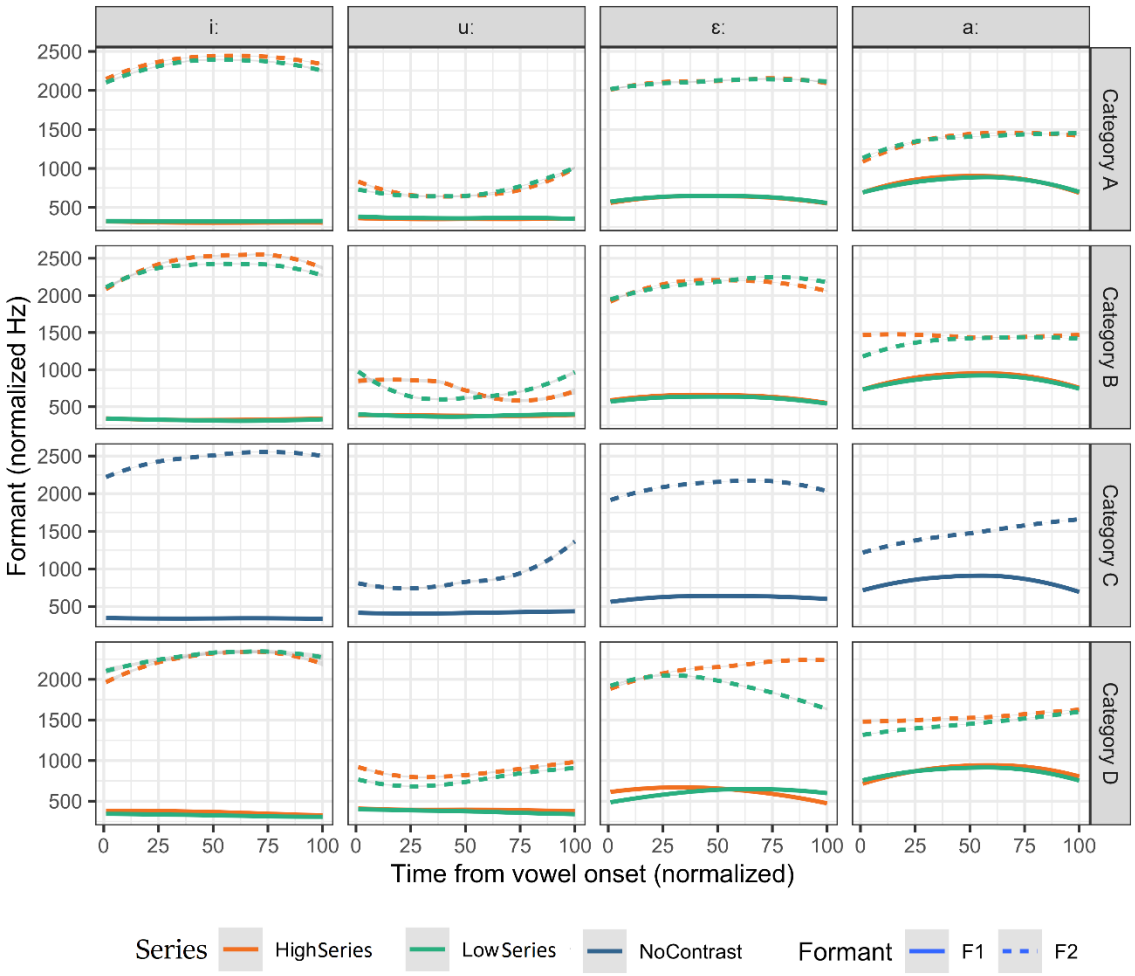


Figure 6-24. F1 and F2 trajectories of four vowel /iː uː ɛː aː/ in the Diêm Điền dialect by *tone category* and *series.*

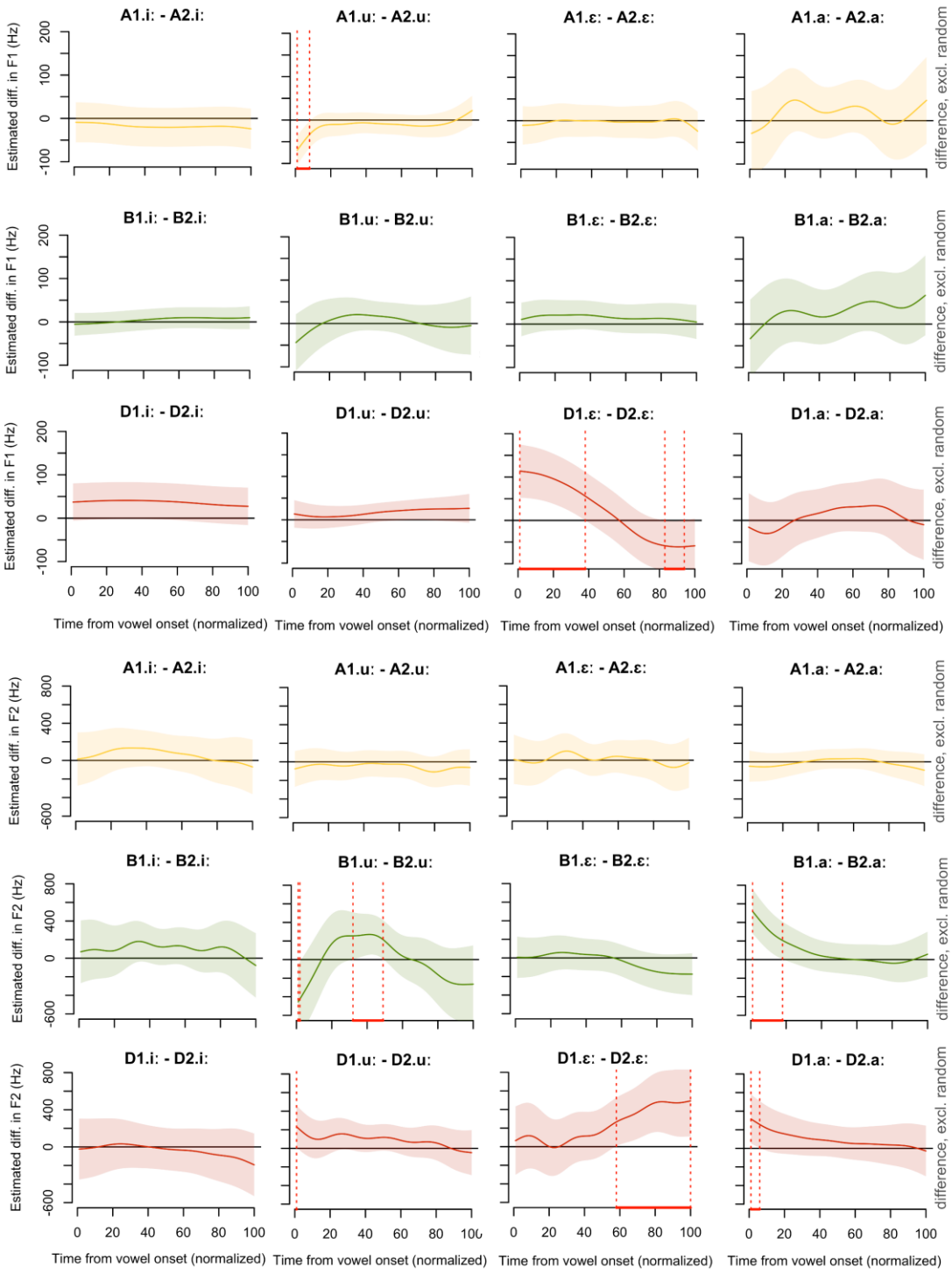


Figure 6-25. GAMM-predicted F1 (three upper rows) and F2 (three lower rows) difference between high- and low-series vowels in Diêm Điênf by *tone category* and *vowel*. The ribbons represent 95% confidence intervals. At any time point, if the ribbons do not touch the horizontal line at y = 0, the difference is significant. Vertical dotted red lines and a red bar on the x-axis further mark significant intervals.

The phonetic realization of Diêm Điền tones and their relation to historical tone categories are summarized in Table 6-12.

Table 6-12. Tone system of the Diêm Điền (Quảng Bình) dialect. The creaky and breathy phonation of tones are marked by the IPA symbols for breathiness (◌̤) and creakiness (◌̰) under the phonetic values of the tones. C1 and C2 tones are phonetically indistinguishable.

	*A category (*open)*	*B category (*-ʔ)*	*C category (*-h)*	*D category (checked)*
Series 1 (High register or voiceless onsets)	44	13 (tense)	53̰	24 + stop (tense)
Series 2 (Low register or voiced onsets)	55̤	42̰		43 + stop

6.3.4 Interim: tone systems in North-Central dialects

Table 6-13 summarizes the tone systems and phonetic realization of tones in three North-Central dialects for easier comparison.

While Cổ Định and Diêm Điền both have five tones in unchecked syllables, with the same tone merger between C1 and C2, Nghi Ân has two tone mergers between B1 and C1, and B2 and C2, resulting in a four-tone system in unchecked syllables. Nghi Ân tones are not marked by salient non-modal phonation (even if some tones have subtle tenseness), while two tones in Cổ Định and Diêm Diền dialects, B2 and C1-C2, have final creaky phonation. The location of this creaky phonation coincides with the lowest f0 level of these tones, suggesting a correlation between phonation and f0. The Diêm Điền dialect has a breathy phonation throughout its low-series tone A2, whose level f0 is the highest of all its tones. The tone system of Diêm Điền is also peculiar in that low-series tones have a higher f0 than their high-series counterparts. In all three dialects, the two checked tones, D1 and D2, are usually half as long as the other tones. Unchecked tones do not show any consistent

duration difference. Synchronically, tone does not affect vowel quality in the Diêm Điền dialect. In the Nghi Ân dialect, however, close vowels—and open-mid vowels, as will be pointed out in the next section—are lowered in tones that derive from the low series, showing vowel opening or rising diphthongization. These vowel changes are also attested in the Cổ Định dialect, although they are less consistent than those in the Nghi Ân dialect. A more systematic investigation of the vowel systems of North-Central dialects in comparison with Standard Vietnamese is presented in the next section.

Table 6-13. Tone systems of Cổ Định, Nghi Ân, and Diêm Điền dialects. Some tones have accompanied phonation, breathy (◌̤) or creaky (◌̰).

<table>
<tr><th></th><th>A category (*open)</th><th>B category (*-ʔ)</th><th>C category (*-h)</th><th>D category (checked)</th></tr>
<tr><td colspan="5">Cổ Định</td></tr>
<tr><td>Series 1 (High register or voiceless series)</td><td>44</td><td>45</td><td rowspan="2">31̰2</td><td>45 + stop
traces of opening diphthongization</td></tr>
<tr><td>Series 2 (Low register or voiced series)</td><td>32 (tense)
traces of opening diphthongization</td><td>42̰
traces of opening diphthongization</td><td>32 + stop (tense)</td></tr>
<tr><td colspan="5">Nghi Ân</td></tr>
<tr><td>Series 1 (High register or voiceless series)</td><td>55</td><td colspan="2">53</td><td>54 + stop</td></tr>
<tr><td>Series 2 (Low register or voiced series)</td><td>33 (tense)
opening diphthongization of close and open-mid vowels</td><td colspan="2">31 (tense)
opening diphthongization of close and open-mid vowels</td><td>32 + stop (tense)
opening diphthongization of close and open-mid vowels</td></tr>
<tr><td colspan="5">Diêm Điền</td></tr>
<tr><td>Series 1 (High register or voiceless series)</td><td>44</td><td>13 (tense)</td><td rowspan="2">53̰</td><td>24 + stop (tense)</td></tr>
<tr><td>Series 2 (Low register or voiced series)</td><td>5̤5̤</td><td>42̰</td><td>43 + stop</td></tr>
</table>

6.4 The vowel system from Proto-Vietic to Vietnamese dialects

6.4.1 Vowel correspondences between the standard Northern and North-Central dialects

My second wordlist (cf. §6.2.1) provides more examples of vowel changes found in the Nghi Ân and Cổ Định dialects. Compared to Proto-Vietic and the standard Northern dialect, vowels in these two North-Central dialects tend to be unchanged in syllables with high-series tones and more open, or exhibit rising diphthongization, in those with low-series tones.

Lines 1-6 in Table 6-14 show that while the standard Northern dialect has the vowel /iː/ in syllables with low-series tones, the equivalents in the Nghi Ân and Cổ Định show a rising diphthongization, which I transcribed in the conventional way as [əj]. In example 7, the vowel in these two North-Central dialects is [e], being more open than the standard dialect /iː/. These first seven examples show that the Diêm Điền dialect patterns with the standard Northern dialect. In examples 8-13, high-series *iː is retained in the standard dialect (or changed into [əj] in example 13) but remains unchanged in the North-Central dialects.

Table 6-14. Close front vowel (assumed to derive from *iː) and vowel correspondences between Vietnamese dialects.

	Gloss	*Proto-Vietic*	*Vietnamese orthography*	*Standard Vietnamese*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
Rising diphthongization or vowel opening in the low series in Cổ Định and Nghi Ân dialects							
1	*horizontal pillars of the house*		vì	vi^{A2}	vəj^{A2}	vəj^{A2}	vaj^{A2}
2	*elder sister*	*ɟiːʔ	chị	tɕi^{B2}	tɕəj^{B2}	tɕəj^{B2}	tɕi^{B2}
3	*vulgar*		đĩ	ɗi^{C2}	ɗəj^{C1}	ɗəj$^{B2\text{-}C2}$	ɗi$^{B2\text{-}C2}$
4	*younger (f.) in law*		dì	zi^{A2}	zəj^{A2}	zəj^{A2}	zi^{A2}
5	*kneeling*		quỳ	kʷi^{A2}	kʷəj^{A2}	kʷəj^{A2}	kʷi^{A2}
6	*dysentery*		lị	li^{B2}		ləj^{B2}	ni^{B2}
7	*to swell*		phình	fiŋ^{A2}	feŋ^{A2}	feŋ^{A2}	fiŋ^{A2}
No vowel changes in the high series in Cổ Định and Nghi Ân dialects							
8	*bird*	*-ciːm	chim	tɕim^{A1}	tɕim^{A1}	tɕim^{A1}	*ko^{A2}*
9	*eyelid*	*ɓiːlʔ	mí	mi^{B1}	mi^{B1}	mi^{B1}	mi^{B1}
10	*few*	*ʔiːt	ít	ʔit^{D1}	ʔik^{D1}	ʔit^{D1}	ʔik^{D1}
11	*holding back*		níu	niw^{B1}	niw^{B1}	*ɲɔːk^{D2}*	niw^{B1}
12	*(kind of) monkey*	*kʰih	khỉ	xi^{C1}	xi^{C1}	xi^{B1}	xi^{B2}
13	*head louse*	*ciː^{3}	chấy	tɕəj^{B1}	tɕi^{B1}	tɕi^{B1}	tɕəj^{B1}

In Table 6-15, some examples (1-7) show that the close back vowel /uː/ in the standard dialect tends to correspond to the two more open vowels /ɔː, oː/ in Cổ Định and Nghi Ân, or even to the rising diphthong [əw] in examples (8-9). In the high series (lines 10-23), the standard dialect has the rhymes /oː, əw/, which are two common reflexes of the proto-vowel *uː, but Cổ Định and Nghi Ân have /uː/ in most cases. However, we will see in §6.4.2 that high-series *uː did not uniformly change to /oː, əw/ in the standard dialect. The Diêm Điền dialect again generally patterns with the standard dialect. Line 24 is a counterexample where close vowel lowering occurs in the high series in Nghi Ân.

Table 6-15. Close back vowel (assumed to derive from *uː) and vowel correspondences between Vietnamese dialects.

	Gloss	*Proto-Vietic*	*Vietnamese orthography*	*Standard Vietnamese*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
Vowel opening or rising diphthongization in the low series in Cổ Định and Nghi Ân dialects							
1	*white skin of fruits*		cùi	kuj^{A2}	kuj^{A2}	koj^{A2}	kuj^{A2}
2	*to carry on the back (in a basket)*		gùi	ɣuj^{A2}	ɣuj^{A2}	ɣoj^{A2}	ɣuj^{A2}
3	*grandparents*		cụ	ku^{B2}	ko^{B1}	ko^{B1}	ku^{B2}
4	*Basella alba*		mùng	muŋ^{A2}	moŋ^{A2}	moŋ^{A2}	moŋ^{A2}
5	*to punch*		thụi	tʰuj^{B2}	tʰuj^{B2}	tʰoj^{B2}	
6	*to touch*		động	ɗoŋ^{B2}	ɗɔŋ^{B2}	ɗɔŋ^{B2}	ɗuŋ^{B2}
7	*clumsy*		vụng	vuŋ^{B2}	voŋ^{B2}	voŋ^{B2}	vuŋ^{B2}
8	*old*		cũ	ku^{c2}	kəw^{c1}	kɔ^{B2}	ku^{B2}
9	*mahogany*		gụ	ɣu^{B2}	ɣəw^{B2}	ɣəw^{B2}	ɣu^{B2}
No vowel changes in the high series in Cổ Định and Nghi Ân dialects							
10	*flies gathering*		bâu	ɓəw^{A1}	ɓu^{A1}	ɓu^{A1}	ɓu^{A1}
11	*Cyperus rotundus*		gấu	ɣəw^{B1}	ɣəw^{B1}	ku^{B1}	ɣəw^{B1}
12	*daughter in law*	*-juː	dâu	zəw^{A1}	zu^{A1}	zu^{A1}	zəw^{A1}
13	*hide*		giấu	zəw^{B1}	zəw^{B1}	tʰu^{A1}	tʰu^{A1}
14	*brown color*		nâu	nəw^{A1}	nu^{A1}	nu^{A1}	nəw^{A1}
15	*deep*	*c-ruː	sâu	səw^{A1}	su^{A1}	su^{A1}	tʰu^{A1}
16	*buffalo*	*c-luː	trâu	tɛəw^{A1}	tɛu^{A1}	tɛu^{A1}	təw^{A1}
17	*rice husk*		trấu	tɛəw^{B1}	tɛu^{B1}	tɛu^{B1}	təw^{B1}
18	*navel*	*p-suːɲʔ	rốn	zon^{B1}	zun^{B1}	zun^{B1}	zun^{B1}
19	*kiss*	*huːɲ	hôn	hon^{A1}	hun^{A1}	hun^{A1}	hon^{A1}
20	*intelligent*		khôn	xon^{A1}	xun^{A1}	xun^{A1}	xun^{A1}
21	*lips*	*c-ɓuːj	môi	moj^{A1}	muj^{A1}	muj^{A1}	moj^{A1}
22	*dark, evening*	*suːlʔ	tối	toj^{B1}	tun^{B1}	tuj^{B1}	tuj^{B1}
23	*rotten*		thối	tʰoj^{B1}	tʰun^{B1}	tʰuj^{B1}	tʰuj^{B1}
24	*sap*	*ɓuh	mủ	mu^{C1}	mu^{C1}	mo^{B1}	mu^{B2}

Examples 1-5 in Table 6-16 show that in the low series, the Nghi Ân dialect has the

open vowel /ɔː/, while the most common correspondence in all other dialects is the open-mid vowel /oː/. Based on additional informal elicitation I conducted after detecting this pattern, this vowel change oː > ɔː in the low series seems to occur uniformly in the Nghi Ân lexicon. However, oː > ɔː is not attested in the high series in any of the dialects under study, as exemplified by lines 6-11 in Table 6-16.

Table 6-16. Open-mid back vowel assumed to derive from *oː and vowel correspondences between Vietnamese dialects.

	Gloss	*Proto-Vietic*	*Vietnamese orthography*	*Standard Vietnamese*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
Vowel opening in the low series in the Nghi Ân dialect							
1	*grumpy*		cộc	kok^{D2}	kɔk^{D2}	kɔk^{D2}	kuk^{D2}
2	*hurry, hasten*		vội	voj^{B2}	voj^{B2}	vɔj^{B2}	ɣəp^{D1}
3	*abundantly flowering*		rộ	zo^{B2}	zo^{B2}	zɔ^{B2}	zo^{B2}
4	*un, one*	*moːc	một	mot^{D2}	mot^{D2}	mɔt^{D2}	mot^{D2}
5	*upside down*		lộn	lon^{B2}	lon^{B2}	lɔn^{B2}	non^{B2}
No vowel opening in the high series in the Nghi Ân dialect							
6	*termite, termite*	*k-moːlʔ	mối	moj^{B1}	mon^{B1}	moj^{B1}	moj^{B1}
7	*ignorant*		dốt	zot^{D1}	zot^{D1}	zot^{D1}	zot^{D1}
8	*embryo*		phôi	foj^{A1}	foj^{A1}	foj^{A1}	
9	*capital*		vốn	von^{B1}	von^{B1}	von^{B1}	von^{B1}
10	*entrer, to enter*		vào	vaːw^{A2}	vo^{A1}	vo^{A1}	vo^{A1}
11	*where*		đâu	ɗəw^{A1}	mo^{A1}	mo^{A1}	ɗəw^{A1}

While working with my Nghi Ân speakers, I noted other low-series-conditioned vowel changes in this dialect, for example, consistent changes of low-series eː > ɛː and low-series əː > aː. By contrast, the vowels eː and əː remain unchanged in the high series. The two open vowels ɛː and ɔː are unchanged in both series, while the back vowel aː is rounded to a complex vowel [ɑ^{a}] or other rhymes with the feature [+round] depending on

the original rhymes, also irrespective of tone series. Similar changes can be observed in some words of the Nghi Ân dialect, as shown in the second wordlist (Appendix AA), although they are not abundant because the second wordlist was not originally designed to investigate the entire vowel systems of three North-Central dialects.

In short, close and open-mid vowels in the Nghi Ân dialect tend to be open or to have rising diphthongization in the low series. These patterns differ from those found in Austroasiatic register languages in which such vowel changes are usually attested in the ***high register*** (cf. Chapter 2). The Cổ Định dialect shows the same tendency, though less consistently. The Diêm Điền dialect, on the other hand, generally patterns with the standard Northern dialect in its vowel system and does not exhibit vowel changes conditioned by tone series.

6.4.2 Vowel changes in standard Northern Vietnamese

Now that I have established that there are some unexpected series-conditioned vowel changes in North-Central Vietnamese, let us have a closer look at possible vowel changes conditioned by tone series in standard Northern Vietnamese. Table 6-17 summarizes the distribution of reflexes of each *proto-vowel* by *coda type* and *register* in Ferlus's list of reconstructed Proto-Vietic etyma (i.e. the third wordlist). It also includes the number of instances and the percentage of vowel changes in each series. If register-conditioned vowel changes did occur in the standard Northern Vietnamese, we would expect asymmetries between series, and the changes should follow the patterns commonly observed in register languages, by which vowels are more open or rising diphthongized in the high register and/or more closed or falling diphthongized in the low register (Huffman, 1985b).

Table 6-17. Statistics of vowel changes in standard Northern Vietnamese from Proto-Vietic, organized by syllable structure in Proto-Vietic according to Ferlus (2014).

	High series			Low series		
Coda	*No. of proto-forms*	*No. of changes*	*Percentage*	*No. of proto-forms*	*No. of changes*	*Percentage*
Vowel *i: > əj, aj						
Open	4	3	75%	3	3	100%
Fricative	3	—	—	—	—	—
Glottal	7	3	43%	5	1	20%
Glide	—	—	—	1	—	—
Sonorant	5	2	40%	1	—	—
Stop	4	—	—	2	—	—
Total	**23**	**8**	**35%**	**12**	**4**	**33%**
Vowel *u: > o: | *u: > əw, aw						
Open	9	5	56%	5	4	80%
Fricative	5	4	80%	3	1	33%
Glottal	21	11	52%	7	2	29%
Glide	4	1	25%	2	—	—
Sonorant	8	2	25%	3	—	—
Stop	13	5	38%	5	—	—
Total	**60**	**28**	**47%**	**25**	**7**	**28%**
Vowel *e: > əj > aj						
Open	8	7	88%	1	1	100%
Fricative	3	—	—	—	—	—
Glottal	7	4	57%	3	—	—
Glide	1	—	—	—	—	—
Sonorant	7	—	—	2	—	—
Stop	7	—	—	1	—	—
Total	**33**	**11**	**33%**	**7**	**1**	**14%**
Vowel *o: > aw						
Open	4	2	50%	1	—	—
Fricative	11	—	—	—	—	—

Glottal	20	4	20%	6	1	17%
Glide	4	1	25%	__	__	__
Sonorant	8	__	__	7	__	__
Stop	5	__	__	3	__	__
Total	**52**	**7**	**13%**	**17**	**1**	**6%**

Vowel *ɛː > iə						
Open	2	__	__	__	__	__
Fricative	10	2	20%	__	__	__
Glottal	8	4	50%	6	1	17%
Glide	3	__	__	3	__	__
Sonorant	7	1	14%	2	__	__
Stop	11	1	9%	1	__	__
Total	**41**	**8**	**20%**	**12**	**1**	**8%**

Vowel *ɔː > uə						
Open	7	1	14%	5	1	20%
Fricative	11	__	__	1	__	__
Glottal	27	8	30%	8	3	38%
Glide	2	1	50%	4	1	25%
Sonorant	5	__	__	3	1	33%
Stop	12	3	25%	6	1	17%
Total	**64**	**13**	**20%**	**27**	**7**	**26%**

Vowel *aː > iə						
Open	8	2	25%	6	__	__
Fricative	16	3	19%	6	2	33%
Glottal	56	8	14%	17	4	24%
Glide	9	1	11%	9	1	11%
Sonorant	29	3	10%	14	3	21%
Stop	23	1	4%	13	1	8%
Total	**141**	**18**	**13%**	**65**	**11**	**17%**

The results in Table 6-17 reveal two weak patterns.

(1) Vowel changes are more frequent in open syllables that originally had the two close vowels *i: and *u: and the open-mid vowel *e:, independently of tonal series. Although we need to be very careful due to the small number of words included in these tables, these vowels may have undergone change more often in open syllables and before laryngeal codas (perhaps after the loss of these laryngeal codas). Otherwise, coda types do not seem to condition vowel changes.

(2) The proportions of vowel changes are roughly the same in the high and the low series, except perhaps for a slight tendency to *u: and *e: lowering / diphthongization in the high series. In any case, vowels do not show consistent and regular series-conditioned changes in standard Northern Vietnamese.

Therefore, the above empirical evidence, except perhaps for a weak subpattern in high-series *u: and *e: that would need to be further explored, tends to confirm that there are no register-conditioned vowel changes in the standard Northern Vietnamese, as suggested by Ferlus (1997b).

6.5 Discussion and interim summary

6.5.1 Are there remnants of register in Vietnamese tone systems?

The results of this chapter established the phonetic properties of three North-Central Vietnamese dialects, showing that the tone systems of these dialects use f0 height, f0 contour, phonation type, duration, and, though to a lesser extent and more dialect-specifically, vowel quality to differentiate tones. However, the question remains: do any of

these phonetic properties suggest that an early multi-property register contrast shaped Vietnamese tones? Three findings are worth discussing: 1) the tone-vowel cooccurrences in the Nghi Ân dialect (and to a lesser extent in Cổ Định), 2) the breathy phonation in A2 in the Diêm Điền dialect, and 3) the patterns of tone fusion/mergers in the three dialects.

6.5.2 Tone-vowel cooccurrences

The vowel changes conditioned by low-series tones in the Nghi Ân dialect are interesting in two respects. Firstly, they provide an additional example of tone-vowel cooccurrences that are rarely attested in the world's languages (Nguyễn, 1993; Ratliff, 2010; Donohue, 2017; Tạ, 2021). This means that tone is not always and only pitch; rather, a bundle of phonetic cues such as f0, phonation type, duration, and vowel quality can at the same time signal tones. Looking from this perspective, in ESEA languages, tone cues do not differ from register cues (Bradley, 1982a; Alves, 1995; Ferlus, 1998b; Thurgood, 2002). Secondly, they confirm that vowel opening and rising diphthongization are often associated with tenser phonation (Gregerson, 1976; Ferlus, 1979a; Huffman, 1985b; Esposito, Sleeper, & Schäfer, 2019). In register languages, this tenser phonation is normally associated with the high register, but as we have seen in §6.3.2.2, it is instead found in low-series tones in the Nghi Ân dialect. Therefore, it seems to be the tense phonation found in modern Nghi Ân, rather than an original register contrast realized through several acoustic properties, that is responsible for vowel changes. This does not necessarily mean that tenser phonation directly conditions vowel changes in Nghi Ân or in register languages (Thurgood, 2002), as the two phonetic properties might be conditioned by the same articulation or actively controlled for to create an integrated perceptual property (Kingston et al., 1997), but it seems to suggest that some

spectral properties associated with tenseness affect or are correlated with vowel quality.

How did tenseness develop in low series tones in Nghi Ân? If we assume that PVM had a register system, we would have to claim that the breathy phonation normally associated with the low register turned into tenseness. Since a scenario for such a shift is difficult to imagine, it is perhaps more likely that the low register originally had a low f0 that came to be associated with tense phonation. In fact, tense phonation often slows down vocal fold vibrations (Gerfen & Baker, 2005; Keating & Garellek, 2015; Garellek, 2019; Dawson et al., 2022), and it is not uncommon to have a tense/creaky phonation in the lower f0 range (Blomgren, Chen, Ng, & Gilbert, 1998; Kuang, 2013a). The connection between Nghi Ân vowels changes and register would thus be indirect.

A similar but weaker pattern of tense voice diphthongization was also found in the Cổ Định dialect (§6.3.1), where the low-series tones have a tenser phonation and are accompanied by more open vowels than their high-series counterparts. As in Nghi Ân, these vowel differences are unlikely to derive from register but seem to be a phonation-based effect only.

In contrast, the standard Northern dialect exhibits possible register-conditioned vowel changes in the high register, *uː > oː, əw and *eː > əj, aj. These changes would be in line with the lowering and rising diphthongization of vowels that often occurs in register languages of the Austroasiatic phylum (Huffman, 1985b). However, since these changes are not regular and are limited to two vowels, more work is necessary before any claims can be made. Therefore, I will adopt the conservative position that there are no vowel changes that were directly conditioned by register in Vietnamese, following Ferlus (1997b) and against Nguyễn (1995) and Gregerson (1976).

6.5.3 Breathy phonation in a low-series tone

In the Diêm Điền dialect, the low-series tone A2 is higher in f0 and has a breathier phonation than its high-series counterpart A1. Since it is cross-linguistically uncommon to have a breathier phonation in the high f0 range (Andruski & Ratliff, 2000; Kuang, 2013a; Garellek, 2019), a straightforward cause-effect account of this cooccurrence is unlikely. If one considers that PVM had a voicing contrast, as normally assumed (Ferlus, 1975; Thompson, 1976; Ferlus, 2014), then this breathiness would be one of the phonetic properties resulting from onset devoicing, a process that would have occurred after tonogenesis from codas, in a language that already had three tones. However, if a register contrast is reconstructed at the Proto-Vietic level, the breathiness in Diêm Điền A2 would be a register property that has been preserved in PVM and that survived in some Vietnamese dialects. I will discuss this further in Chapter 7, but in any case, this breathiness is, to the best of my knowledge, the first instance of a breathy phonation consistently present in a Vietnamese tone, regardless of the dialect. This breathy phonation has been found in the Northern Vietnamese A2, but only in some speakers (Vũ, 1981, 1982; Edmondson & Lợi, 1997), and it is often described without full instrumental evidence (Nguyễn, 2002; Pham, 2002; Tạ, 2014).

The surviving breathiness in Diêm Điền A2 also explains the apparent f0 height reversal between low-series tones, A2, B2, and D2, and high-register tones, A1, B1, and D1. It is unlikely that f0 was higher in low-register tones right after tonogenesis because a high f0 in the low-register or low-tone series is rarely attested. I know of a single example in Mah Meri, an Aslian language of the Austroasiatic phylum (Stevens, Kruspe, & Hajek, 2006; Kruspe & Hajek, 2009). Therefore, one can assume that high- and low-series tones in Diêm Điền originally had the expected f0 height level, i.e., higher in high-series tones, but

that the tones then gradually drifted and crossed position in the f0 range. The question that arises is: how could this have happened without a tone merger between low- and high-series tones as they crossed paths? The presence of breathiness in low-register tones seems to provide an explanation: the two members of each tone pair would have been kept distinct because they had different phonation (and/or different contours in the case of tone pairs B and D). Phonation, if it were still present, would then have been lost in B2 and D2.

If the breathiness found in A2 in some Vietnamese varieties is a remnant of the phonation associated with the low register, why would it be absent in low-series tones B2, C2, and D2 in all previous descriptions of Vietnamese dialects? It is possible that breathiness was lost early in B and D tone categories because of the conflicting phonation (tense/creaky) derived from the glottal and stop codas in these categories (Pulleyblank, 1978). Phonation contours, like a breathy-creaky phonation, could be dispreferred, which would explain why attested cases of such contours are so rarely attested in the Austroasiatic phylum (Thongkum, 1986; Edmondson, 1996; DiCanio, 2009) and in other languages in the world (DiCanio, 2009). As for the absence of breathiness in C2, it could be explained by a perceptual confusion of low register-conditioned breathiness with the glottal opening gesture associated with final -h (cf. Chapter 3).

6.5.4 Tone fusion/mergers in North-Central Vietnamese dialects

From Thanh Hoá to the southernmost tip of Vietnam, C1 and C2 are realized identically. This merger only skips the Nghệ Tĩnh dialects, whose defining tone merger is between B2 and C2. If one could explain the origin of the confusion between C1 and C2 in Thanh Hoá

tone systems, the explanation would probably account for C1-C2 confusion in Central and Southern dialects because people from Thanh Hoá accounted for a large proportion of the population that moved to new territories of Vietnam during its southward expansion. This phase of territorial expansion spanned from the 11th to 19th centuries and began at the border between Hà Tĩnh and Quảng Bình, which was once the border between Vietnam and Champa (Ngô, 1993; Tana, 2018).

There are two possible scenarios. Either the Thanh Hoá dialect had distinct C1 and C2 after tonogenesis, and these two tones blended. This is analogous to what happened in Mường dialects, some of which have a full tone system with six-plus-two tones, while others show different tone mergers between B1 and B2, B2 and C2 or A2 and C2 (Ferlus, 1998b; Nguyễn, 2009d; Nguyễn, 2016). If there was such a tone merger between C1 and C2 in Thanh Hoá, it happened early, before settlers from that area started moving south. The second scenario is that there was never any split in the C category. This would parallel the tone system of Rục studied in Chapter 5, where syllables ending in final -h exhibit no f0 difference between registers. The only drawback with this scenario is that it would force us to claim that tonogenesis from codas happened separately in two groups of Vietnamese dialects, the Northern dialects (and the Nghệ Tĩnh, as we will see below), which would have split tone C, and the Thanh Hoá dialects, which are the forebears of all Southern-Central and Southern dialects, that would have never split the C tone[33]. This would force us to consider that Vietnamese has at least two branches that split relatively early (possibly immediately at the break-up of PVM). This hypothesis of different Pre-Việt-Mường

[33] These dialects would include the Diêm Điền dialect, that has a single C tone, even if the settlers who brought it to the area came from both Thanh Hoá and Thái Bình (an area of North Vietnam where C1 and C2 are distinct).

branches is not new since it has been advanced at least twice to explain the formation of different Vietnamese dialects (Nguyễn, 1995; Nguyễn, 2009d). I will go back to this point in Chapter 7.

The Nghi Ân dialect is different. It has a B2-C2 merger characteristic of Nghệ Tĩnh dialects but further conflates B1 and C1. Its four-plus-two-tone system is reminiscent of the pattern of merger observed in the Pọong and Toum dialects of the Pọong language, the Maleng Bro dialect of the Maleng language (cf. Chapter 3), and the Vietnamese dialects spoken in Hướng Hoá (Tuyên Hoá, Quảng Bình) (Ferlus, 1998b). Ferlus (1998b) explained these tone confusion patterns as the outcome of a merger between *-ʔ and *-h prior to tonogenesis. If one were to apply this explanation to the tone system of the Nghi Ân dialect, one would have to consider it an isolated dialect in the Nghi Lộc district because almost all other Nghi Lộc dialects still have distinct B1 and C1[34]. Therefore, it is more economical to treat the tone confusions in the Nghi Ân dialect and other Nghệ Tĩnh dialects as tone mergers.

In the future, perception studies need to be conducted to assess the perceptual weights of the phonetic properties in the tone system of each of the three dialects (and other relevant dialects) to see if there is any sound change in progress in the communities given the high rate of dialect-levelling in Vietnam.

6.5.5 A register contrast in Proto-Việt-Mường?

The results in §6.4.2 show that, with the possible exception of *u: and *e: lowering/

[34] As mentioned somewhere else in this chapter, the distinctive status of B1 and C1 in Nghệ Tĩnh dialects indicates that B and C categories had been formed by tonogenesis, and a later merger conflated the two low-series reflexes, B2 and C2.

diphthongization in the high register, vowel changes from Proto-Vietic to standard Northern Vietnamese are not conditioned by register, as suggested by Ferlus (1997b). This is not a new finding, but it is strengthened by the systematic breakdown of vowel changes by proto-coda and register presented in §6.4.2. The hypothesis made by previous researchers, including myself, that some vowel changes in standard Vietnamese might have been conditioned by register should therefore be considered unlikely at best (Gregerson, 1976; Nguyễn, 1995; Trần, 2015; Tạ, 2021).

The absence of register-induced vowel changes in standard Vietnamese suggests that vowel quality was not a register cue in the ancestor of this modern language or that, if it was a register cue, its role was much more limited than that of f0 and phonation and was not transphonologized during tonogenesis, contrary to what happened in Rục (Chapter 5). The vowel changes conditioned by the low-series tones in Nghi Ân and Cổ Định are of a different nature. They seem to be conditioned by a tense phonation that accompanies tones with a low f0, and this change likely happened after the separation between these dialects and other Vietnamese varieties.

The absence of register-conditioned vowel changes in Vietnamese rules out the possibility that PVM had a register contrast with strong vowel quality modulations, but it does not necessarily preclude the possibility of a register contrast based on other cues. The breathiness found in the low-register tone A2 in Diêm Điền (§6.3.3.2) and standard Vietnamese suggests two equally possible scenarios. The first one is that PVM had a register system cued by f0 and phonation (but not vowel quality), but that the phonation cue was lost in most Vietnamese dialects. Systematic instrumental investigation of phonation in Vietnamese dialects (using spectral measures and electroglottography) might

reveal that traces of this original phonation are more widespread than currently believed. Alternatively, it is possible that PVM had a voicing contrast that gave way to f0 modulations after the development of tones from codas, as normally assumed (Haudricourt, 1954b; Ferlus, 2004), but that these f0 modulations were accompanied by breathiness in the low series (Thurgood, 2002). Evidence for this question is still limited, but in light of the fact that all other Vietic languages have register (as Arem and Rục) or traces of a register contrast, the register hypothesis is more likely. A more complete account of the history of register and tone developments comparing Vietnamese with other Vietic branches is given in the next chapter.

Chapter 7

Discussion and Conclusion

The results presented in Chapters 4, 5, and 6 provide answers to the questions put forward in Chapter 1 on the phonetics of Vietic tonation systems and their contribution to a better understanding of tone, register, and their developments in ESEA languages in general. This final chapter provides a quick summary of the results presented throughout this dissertation and discusses their relevance for our understanding of the diversity of tonation systems in Vietic languages (Section 7.1), the reconstruction of register and tone contrasts in Proto-Vietic (section 7.2), and different tonogenetic effects that final laryngeals can have in different languages (section 7.3). This Chapter and this dissertation close with some concluding remarks in Section 7.4.

7.1 The diversity of tonation systems in Vietic languages

The results presented in Chapters 4-6 showed that the Vietic varieties studied in this dissertation, Arem, Rục, and three North-Central Vietnamese dialects, have distinct

tonation systems, varying not only in the number of tonation units they distinguish, but also in the diversity of their phonetic properties and their relative prominence in the realization of tonation. Among these varieties, Arem can be considered to have a typical Austroasiatic register contrast and no tone, while Vietnamese dialects have tone systems and only limited remnants of a register contrast. Rục is in between these two extremes, with a hybrid system combining tone and register.

7.1.1 Arem: register without f0 modulations

The results of Chapter 4 established that Arem has a register contrast whose primary phonetic cue is vowel quality differences between the high and low registers. Each register in Arem has a subsystem of vowels derived from the same proto-vowel system, by which vowels are more open or show rising diphthongization in the high than the low register. These patterns parallel typical register-conditioned vowel changes found in Austroasiatic languages with a register contrast (Henderson, 1952; Huffman, 1976; Ferlus, 1979a; Huffman, 1985b). The Arem register contrast is also consistently signaled by a breathier phonation in the low register, indicated by the spectral measure H1*-H2*, the measure of periodicity CPP, and semi-articulatory data on the open quotient (OQ) of the glottis. The low register also have a longer VOT than the high register.

In contrast, f0 was not found to differ between the two registers, contra previous descriptions of the Arem tonation system (Trần, 1990; Ferlus, 2013). This means that f0 might never have been a register cue in Arem, just like in many other ESEA register languages (Henderson, 1952; Gregerson, 1976; Brunelle et al., 2020; Brunelle et al., 2022a). Alternatively, f0 may have once been a secondary cue of the Arem register contrast that was finally lost

as the language phonologized register-conditioned vowel changes into two subsystems of vowels (and preserved phonation). In any case, the absence of f0 in the Arem register system seems to disprove L-Thongkum's claim that "pitch differences are always present in register languages […]. Unfortunately, [they have] always been ignored or unheard by Mon-Khmer specialists" (1988, p. 328).

Proto-Vietic final glottals, *-ʔ and *-h, and glottalized sonorant codas are still preserved in Arem. Since their effects on the duration, f0, and phonation of preceding vowels are variable across registers and speakers, I consider Arem to be atonal, following Nguyễn (1988) and contra Trần (1990); Ferlus (2013). The results in Chapter 4 also showed that despite variation, glottalized sonorant codas generally pattern with -ʔ in their effects on preceding vowels, which explains why the same B tone category is derived from these two types of codas in other Vietic languages. The data collected in this dissertation is not sufficient to answer the question of the origin of glottalized sonorant codas in Vietic, but it does not support Ferlus (2004)'s hypothesis that a tenseness inherent to sesquisyllabic (but not monosyllabic) words led to the glottalization of final sonorants because sesquisyllabic words have both glottalized and non-glottalized sonorant codas, like *takɯŋ* 'chicken heel' vs. *latɯŋˀ* 'wooden wall,' and because glottalized sonorant codas are also present in monosyllabic words that show no evidence of ever having had a presyllable, like *tʰanˀ* 'hard,' *liəŋˀ* 'hover,'… (more examples are given in Appendices 4-2 and 4-3). My data also argue against Gehrmann (2022)'s proposal that creakiness developed in Proto-Vietic sonorant-ending syllables with low vowels, i.e., *VN (low vowels) > V̰N > VNˀ (cf. §2.2.2.2). This is evidenced by the existence of Arem words with glottalized sonorants preceded by both high and low vowels in both registers (Appendices 4-2 and 4-3). The

only remaining explanation is Diffloth (1989a)'s hypothesis that there was a creaky phonation in Proto-Austroasiatic but that it was lost in all branches but Vietic, Katuic, and Pearic. This cannot be settled with internal evidence from Vietic languages and is open for further investigation across the phylum.

7.1.2 Rục: register and tone

The results in Chapter 5 confirm that Rục has four tones, or more precisely, tonation units, in open and sonorant-ending syllables (A1, A2, B1, and B2), as previously documented (Nguyễn et al., 1988; Nguyễn, 1993; Solntsev et al., 2001b). However, I showed that while registers still seem to maintain fairly constant phonation and vowel qualities across tonation categories (A1 and B1 have modal vowels with relatively high F1, while A2 and B2 have breathy vowels with relatively low F1), the tone categories proper do not share fixed f0 contours (for instance, B1 is rising while B2 is falling). VOT in onset stops also differs between low-register and high-register tones: it is longer in syllables with the low-register tones (A2 and B2). Although the data on checked syllables was insufficient for definite generalizations, an inspection of the available data confirmed that these checked syllables have two tones, D1 and D2, distinguished by precisely the same acoustic cues as tones in unchecked syllables, B1 and B2.

In previous studies of Rục, there was no phonetic description of tones in h-ending syllables: researchers, explicitly or implicitly, considered tones in these syllables to be allotones of those in open and sonorant-ending syllables (Nguyễn et al., 1988; Nguyễn, 1993; Solntsev et al., 2001b). My study clearly showed that f0 is indistinct between syllables in the high and low registers, but that other register cues, like F1, phonation type, and VOT, differ

between the two registers, just like in other tone categories (A, B, and D). The neutralization of f0 in h-ending syllables is probably due to the fact that the coda uniformly shortens the vowel and raises its f0 to the top of the f0 range. The f0-raising effect of -h in Arem, and Rục, is important in another aspect: it suggests that -h does not automatically lower the f0 of the preceding vowel, as proposed in Haudricourt (1954b)'s classic hypothesis on tonogenesis. We should therefore revisit the claim that h-ending syllables originally developed a low tone in Vietnamese. I will go back to this point in §7.3.

The relative prominence of the phonetic properties employed to differentiate registers in production is generally mirrored in perception: F1 is the most important cue in both production and perception, followed by phonation type and f0. However, f0 played a much more limited role in the listeners' perception of C tones, which is explained by the absence of f0 differences between C tones in production.

7.1.3 North-Central Vietnamese dialects: tone without synchronic register

In Chapter 6, I looked at three North-Central dialects with full-fledged tone systems and showed that, aside from some breathiness in Diêm Điền tone A2, they exhibit little evidence for register-conditioned phonation and vowel quality differences. Phonation differences between tones in these dialects seem to be attributable primarily to f0 height, a tense phonation being associated with low f0, and vowel changes that appear connected to register can be treated as a consequence of this tenseness rather than derived from an original register contrast.

However, these tone systems show interesting patterns of tone merger. I confirmed

that the key difference between Thanh Hoá and Nghệ Tĩnh tonation systems is that Thanh Hoá dialects, like other Central and Southern dialects, exhibit confusion between tones C1 and C2, while the characteristic tone pattern of Nghệ Tĩnh dialects is the merger of B2 and C2. Some Nghệ Tĩnh dialects show a further conflation of B1 and C1, resulting in four-tone systems, as exemplified by the Nghi Ân dialect studied in this dissertation, but also by other dialects (Võ, 1993; Pham, 2005). The Diêm Điền dialect, although it is located in Quảng Bình province, patterns with Thanh Hoá dialects in terms of tone mergers. It also has a seemingly reverse f0 height between the two tones in A and B pairs, whereby the low-series tones A2 and B2 have an overall higher f0 than their high-series counterparts. This could be explained as tone changes that arose after tonogenesis.

7.2 Reconstruction of register and tone in Vietic

7.2.1 Register in Vietic

The results of Chapter 6 showed that there are no register-conditioned vowel changes in the North-Central dialects. The vowel changes including diphthongizations and vowel lowerings in standard Northern Vietnamese neither showed strong evidence for the effect of the register contrast. These either suggest that PVM had a register contrast with little or no vowel quality modulations, or that PVM had a voicing contrast rather than a register one and that the two-way tone split attested in Vietnamese and Mường was conditioned by a direct phonologization of the f0 modulations caused by voicing. The study of phonation provides limited evidence for the former hypothesis: tone A2 is breathy in Diêm Điền and often reported to be present in Northern dialects (Vũ, 1981; Edmondson & Lợi, 1997; Pham,

2002; Tạ, 2014) and this breathiness could be a remnant of a former register contrast. In Chapter 6, I have speculated that the absence of a similar breathiness in Vietnamese tones B2, C2 and D2 could be due to the articulatory challenges of associated with sustaining complex phonation contours.

As explained in the discussion section of Chapter 6, the register contrast in PVM could be either carried over from some level higher up, likely Proto-Vietic, or have developed out of a devoicing of onset stops in PVM, as is assumed in the classic tonogenetic model (Haudricourt, 1954b; Ferlus, 2004). Since all other Vietic languages have either register or at least one register property (cf. Chapter 3), I propose that a register contrast should be reconstructed in Proto-Vietic, following Gregerson and Thomas (1976) and Gehrmann (2022). This register was probably a typical Austroasiatic register signaled by a bundle of phonetic properties, although the exact phonetic properties it included are more difficult to ascertain. Based on the varieties studied here, it likely included f0, phonation type, and vowel quality. There might have been differences in vowel duration and VOT as well, as found in the Rục and Arem data. Finally, low-register onset obstruents could also have redundant closure voicing like what is observed in other register languages such as Chrau (Tạ, Brunelle, & Nguyễn, 2019; Tạ et al., 2022) and Mnong (Brunelle, Đinh, & Tạ, 2022b), two languages that belong to the Bahnaric branch of Austroasiatic, and Chru (Brunelle et al., 2019; Brunelle et al., 2020) and Raglai (Brown, 2020; Brunelle et al., 2022a), two languages that belong to the Chamic branch of Austronesian. This proto-register then evolved differently in different Vietic branches and subbranches. Differences between Vietic languages in their retention of glottal codas and the consequent formation of tones further complicated the situation, resulting in diverse tonation systems in the language family

(more in the next section). The proposed language tree of Vietic in Chapter 3 is reproduced here in Figure 7-1 with additional information on register properties, tone categories, and retained glottal codas in each language as they are observed nowadays and provides an admittedly very tentative reconstruction of the register contrast from Proto-Vietic to its lower levels.

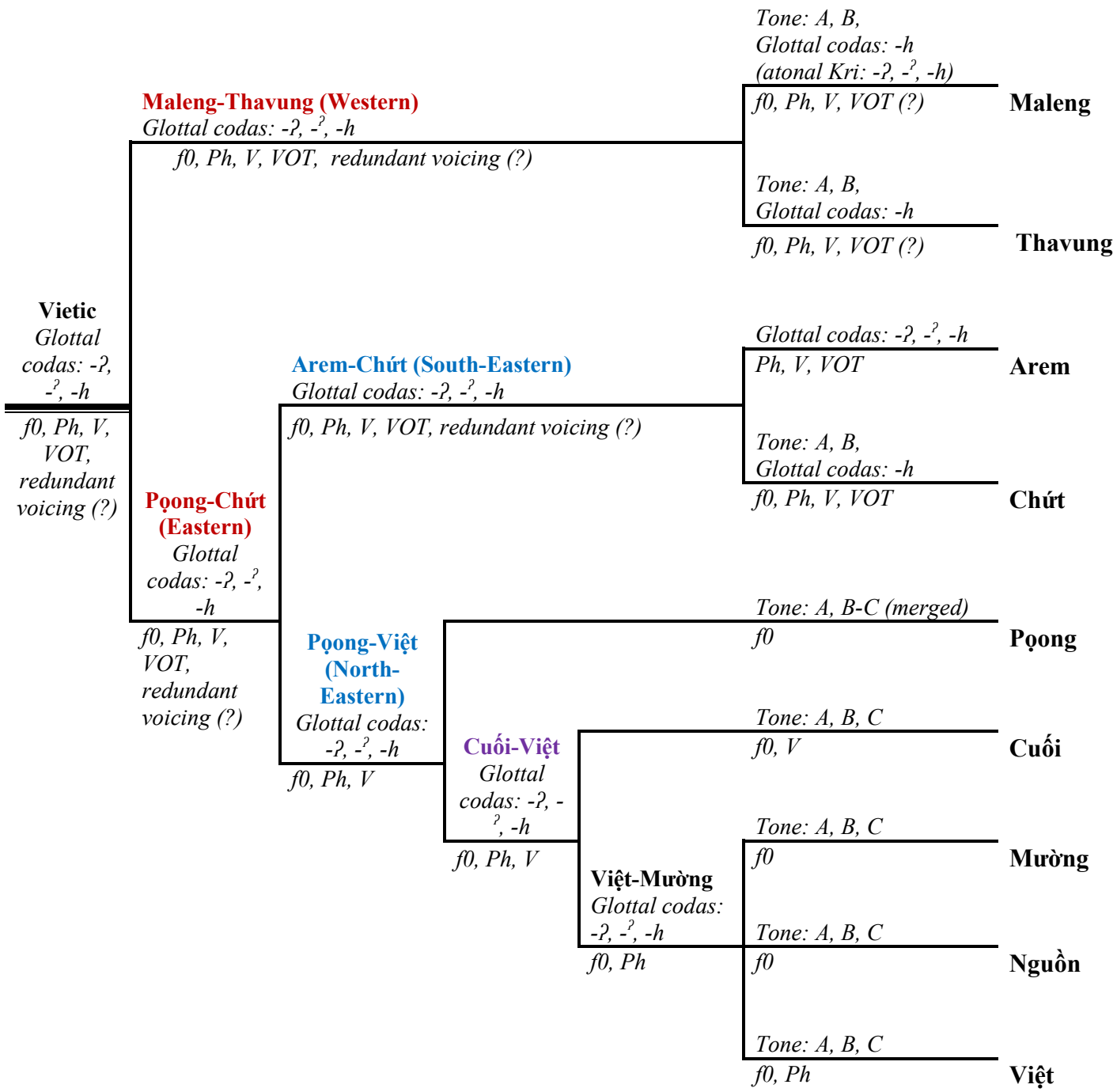


Figure 7-1. Register and tone developments in Vietic languages. The text above the branches lists glottal codas or derived tones in each language. The text below branches lists the register properties present in the tonation system: *f0, Ph*(onation) type, *V*(owel) quality, VOT, and redundant closure voicing. In non-terminal groups, the tonation cues are likely reconstructions. The reconstruction of phonation in Vietnamese (last row) is based exclusively on the breathiness found in A2.

From Figure 7-1, one can see that some languages and dialects kept the strong f0, phonation type, and vowel quality features of the proto-register until now, such as languages in the Maleng-Thavung (Western) clade (Suwilai, 1996; Ferlus, 1998b; Enfield & Diffloth, 2009) and in the Arem-Chứt (South-Eastern) branch of the Pọong-Chứt (Eastern) clade, such as Rục (Nguyễn, 1993; Solntsev et al., 2001b) and Mày (Babaev et al., 2021). Some register languages may have dropped a cue, like Arem, that preserves vowel quality and phonation but no longer makes use of f0. These Western and South-Eastern Vietic languages are often considered more conservative than the North-Eastern languages, not only in their word structure and segmental inventory, but also in their tonation systems. Most languages of the Pọong-Việt (North-Eastern) branch, like Pọong, Vietnamese, and Mường, phonologized the f0 difference between the two registers into tonal contrasts and dropped other cues almost entirely, but Cuối retains modest remnants of register-conditioned vowel changes (Ferlus, 1994b, 1998b).

The reconstruction of a register contrast at Proto-Vietic inevitably leads to a modification of the proto-onset system. There is no longer a voicing contrast in onset obstruents as what has been usually reconstructed (Nguyễn, 1995; Ferlus, 2014); instead, we might consider the proto-language as having a single series of voiceless obstruents with phonetic variation conditioned by the register contrast. In particular, obstruents might have a longer VOT and possibly redundant, non-contrastive closure voicing in the low register compared to the high register. Using the IPA symbol for devoiced segments to represent the low register, the Proto-Vietic onset system, as reconstructed by Ferlus (2014) (Table 3-20), is modified as follows (Table 7-1).

Table 7-1. Proto-Vietic onset system. Rare segments are parenthesized. Phonetic variant of onset obstruents in the low register is marked by the IPA symbol for devoiced segments.

(*)	(pʰ)	(tʰ)	s		(kʰ)	h
	p [p p̥]	t [t t̥]	c [c ç]	ʧ [ʧ ʧ̥]	k [k k̥]	ʔ
	ɓ	ɗ	ʃ			
	m	n	ɲ		ŋ	
	v		j			
		r	l			

7.2.2 Tone in Vietic

Like other reconstructions of Proto-Vietic (Nguyễn, 1995; Ferlus, 2014), the available data on Vietic languages does not justify the reconstruction of tone at the proto-language but rather of final glottals *-ʔ, *-h/s and glottalized sonorant codas. The two clades of the family, Western and Eastern, must be reconstructed with these tonogenetic codas since they are all preserved in modern Kri (Maleng) and Arem, and since -h is preserved in Thavung and Chứt (Figure 7-1). As for the source of final glottalized sonorants in Proto-Vietic, recent progress in reconstructing Proto-Vietic and Proto-Austroasiatic has not settled the issue (Diffloth, 1989a). However, as pointed out above (§7.1.1), the Arem data in this dissertation does not seem to support Ferlus (2004)'s hypothesis on sesquisyllabic tenseness or Gehrmann (2022)'s hypothesis of vowel-height-conditioned register.

Figure 7-1 also reveals a tendency for *-ʔ to drop first in tonogenesis, leaving the *-h intact in many languages with hybrid systems of tone and register, like Maleng, Thavung, and Chứt. Laryngeal codas are suggested to have been dropped in the same order in PVM, although evidence is scanty (Ferlus, 2004; Honda, 2005, 2008). In any case, the

reverse situation, in which *-h would have dropped prior to*-ʔ, is not attested in Vietic languages.

The languages in the Pọong-Việt (North-Eastern) branch are all tonal, but I do not reconstruct tone for their common ancestor. The reason is that tonogenesis is estimated to have happened in Vietnamese in the 6th century at the earliest (Haudricourt, 1954b), or a couple of centuries later (Alves, 2018) based on Sino-Vietnamese correspondences (see §7.3), but Việt-Mường and Pọong languages are estimated to have split much earlier than that. Although, the dating of this split is only based on lexicostatistics (the 7th BCE in Peiros (2004) or at the beginning of the first millennium in Nguyễn (1995)). Therefore, tonogenesis from codas seems to have taken place independently in different branches of the Pọong-Việt (North-Eastern Vietic) group. The question of where we should reconstruct tones (from finals) in the Cuối-Việt subbranch, at Proto-Cuối-Việt or in each independent branch will be discussed further in §7.3.2. I will argue that, in accordance with previous reconstructions, tones developed in PVM and that the two branches of Proto-Cuối-Việt therefore underwent tonogenesis from finals independently.

7.3 Glottal codas and tonogenesis

7.3.1 The variable coarticulatory effects of glottal codas and their impact on tone contours

The final fricative -h has apparent f0-raising and vowel-shortening effects in Rục (Chapter 5), and to some extent, in Arem (Chapter 4), while the final glottal stop -ʔ and glottalized sonorant codas in Arem usually condition a falling f0 contour and a creaky phonation on

preceding vowels. These f0 patterns are the opposite of those assumed by the standard Haudricourtian model (Haudricourt, 1954b). As such, they raise questions about the effects of glottal finals on preceding vowels cross-linguistically and in tonogenesis in particular.

Although it is usually assumed that the glottal codas -ʔ and -h have f0-raising and f0-lowering effects, respectively, and that these effects are responsible for the formation of high and low tones in languages that undergo tonogenesis (Haudricourt, 1954b; Mei, 1970; Matisoff, 1973; Mazaudon, 1976; Pulleyblank, 1978), opposite effects are not hard to find in the literature. For example, *-h was found to be the source of high tones in Vietic languages like Cuối (Nguyễn & Nguyễn, 2019) and Mường Kim Thượng (Nguyễn, 2016), and in other languages such as Jeh, a Bahnaric language in South Vietnam (Gradin, 1966), Tsat, a Chamic language in Hainan (China) (Maddieson & Pang, 1993; Thurgood, 1993), in some Tibeto-Burman languages (Maran, 1973), and in Kra-Dai languages (Norquest, 2007; Sagart, 2019). Moreover, in many languages that preserve a coda -h, it has an f0-raising effect on preceding vowels. Examples include Thavung (Suwilai, 1996; Ferlus, 1998b), Mã Liềng (Ferlus, personal notes), and the Pearic (Austroasiatic) language Chong (Thongkum, 1986). On the other hand, *-ʔ was reconstructed to be the historical source of the falling tone C in the proto-language of the Kra-Dai phylum (Gedney, 1986; Norquest, 2007; Sagart, 2019). Along the same lines, the Tibetan falling tone alternates with final stops accompanied by glottal constriction (Mazaudon, 1976). An f0-lowering effect of the retained *-ʔ is also attested in several languages. In Chong, ʔ-ending syllables have a falling f0 compared to the rising f0 found in syllables ending in -h (Thongkum, 1986). In Wa (Palaungic), both -ʔ and -h condition a falling contour on the f0 of preceding vowels, but they differ in the higher open quotient toward the end of vowels preceding -h (Watkins, 2002). In fact, the

tonal history of Athabaskan languages suggest that syllable final glottals can have opposite tonogenetic effects in closely related languages (Kingston, 2005). In these languages, proto-glottalic codas and the glottal stop glottalized preceding vowels. In languages in which this glottalization was realized as a creaky voice, a low tone developed, but in languages in which this glottalization evolved into a tense voice, the syllables developed a high tone. Similar patterns are also attested in Hlai (Kra-Dai) languages (Norquest, 2007), where glottal codas *-ʔ and *-ɦ from proto-language had different effects on f0 and phonation type on preceding vowels in three groups of Hlai languages, leading to the formation of tones with opposite phonetic values, namely f0 height, f0 contour, and phonation (Figure 7-2).

	PHl	Group 1	Group 2	Group 3
A	*V	*V^{53}	*V^{33}	*V^{33}
B	*Vɦ	*Vh^{55}	*Vɦ^{51}	*V̤ɦ^{21}
C	*Vʔ	*V̰^{11}	*V̰ʔ^{55}	*V̰ʔ^{42}
D	*V͡ʔC	*V͡ʔC^{55}	*V̰͡ʔC^{55}	*V͡ʔC^{55}

Figure 7-2. Reconstructions of Proto-Hlai glottal codas and different tonogeneses in its daughter languages (Norquest, 2007).

The different patterns above suggest that the effects of laryngeal codas on the f0 and phonation of preceding vowels are more complex and language-specific than assumed in traditional models of tonogenesis. These examples illustrate how the same final glottal segment—final glottal stop -ʔ and glottalized codas, or final fricatives -h/-s—could have opposite f0 effects in different languages. This was hinted at by Thurgood (2002), who claimed that both -ʔ and -h have two variants, *tense* (nonbreathy -h and abrupt -ʔ) and *lax* (breathy -ɦ and creaky -ʔ), and that these variants have opposite effects of raising or lowering the f0 in the preceding vowels (Table 7-2).

Table 7-2. Variants of glottal finals and their different f0 effects.

	Glottal fricatives	*Glottal stops*
Pitch raising	[—h nonbreathy]	[—ʔ abrupt]
Pitch lowering	[—ɦ breathy]	[—ʔ creaky]

This typology of the effects of glottal codas on f0 and phonation implies that we need to adopt a more language-specific approach when studying tonogenesis. It also offers more phonetically-grounded explanations for patterns of tone matching in Sino-Vietnamese, as I will argue in the next section.

7.3.2 Uncovering tone-matching patterns in Sino-Vietnamese

In this section, I ask whether the reconstruction of a register contrast in Proto-Vietic, along with a new typology of the effects of glottal finals, can help us better account for phonetic patterns of tone assignment in the Sino-Vietnamese lexicon (cf. §2.4.3), based on our current understanding of tonation formation in Chinese and Vietnamese. The study of tonation formation in Chinese has undoubtedly benefited from multiple sources that are unavailable in the case of Vietnamese. These include studies of rhymes in compiled poetry books, transcription of foreign words, Chinese loanwords in ESEA languages, and direct descriptions of tones in written records, that are all available thanks to the long history of the Chinese writing system (Karlgren, 1957; Pulleyblank, 1962; Pulleyblank, 1978; Sagart, 1999; Ratliff, 2010; Pulleyblank, 2011; Phan, 2013, among many others). Details of the reconstruction of Chinese tones vary between researchers, but the general outline is pretty consistent and will be used as the starting point for a comparison of the phonetic properties of Chinese

and Vietnamese tones at different periods in the development of their respective tonation systems.

The table representing tone correspondences between two layers of the Sino-Vietnamese lexicon, ESV (Early Sino-Vietnamese) and LSV (Late Sino-Vietnamese), and Old and Middle Chinese (OC and MC) that was provided in Chapter 2 is modified and reproduced here for convenience. I added information on an intermediate stage between ESV and LSV, during which MC lost its *-h/s and formed tone category C (*qusheng*) while PVM was still atonal. Chinese words with tone C borrowed into Vietnamese at that stage were therefore treated as open syllables, which later developed A tones (Alves, 2018).

7.3.2.1 Early Sino-Vietnamese (earlier stage)

In the oldest stratum of SV (two first columns in Table 7-3), Chinese *pingsheng* (tone A) corresponds with SV tone A (*ngang/huyền*), Chinese *shangsheng* (tone B) corresponds with SV tone B (*sắc/nặng*) and Chinese *qusheng* (tone C) corresponds with SV tone C (*sắc/nặng*).

Table 7-3. Tone correspondences between different Sino-Vietnamese layers and Old and Middle Chinese tones.

Old Chinese – Early Middle Chinese	*Early Sino-Vietnamese (earlier stage)*	*Early Middle Chinese*	*Early Sino-Vietnamese (later stage)*	*Late Middle Chinese*	*Late Sino-Vietnamese*
1st century BC to 3rd – 4th centuries CE		3rd – 4th centuries CE to 9th century CE		10th – 12th CE onward	
-Ø (later pingsheng)	-Ø (later *ngang/huyền)*	**pingsheng -Ø**	-Ø (later *ngang/huyền)*	**pingsheng -Ø**	tone A -Ø (later *ngang/huyền)*
-ʔ (later shangsheng)	-ʔ (later *sắc/nặng*)	**-ʔ (later shangsheng)**	-ʔ (later *sắc/nặng*)	**shangsheng -Ø**	tone C -Ø (later *hỏi/ngã)*
-h/s (later qusheng)	-h/s (later *hỏi/ngã)*	**qusheng -Ø**	-Ø (later *ngang/huyền)*	**qusheng -Ø**	tone B -Ø (later *sắc/nặng*)

Reconstructions of OC and EMC posit that the language did not have tone, but had a voicing contrast in onset obstruents (Pulleyblank, 1978; Sagart, 1999; Baxter & Sagart, 2014). This suggests that PVM was still atonal at that time. If the two languages were atonal and had the same final glottals, PVM speakers likely borrowed Chinese words with their glottal codas, and these codas later developed into tones in parallel in the two languages. Whatever effects codas had on preceding vowels in the two languages and whether these effects differed is irrelevant at this stage as PVM speakers would have paid attention to the codas themselves rather than the f0 modulations they conditioned. As far as I know, all researchers agree upon this straightforward coda correspondence scenario (Pulleyblank, 1978; Sagart, 1986; Ratliff, 2010; Phan, 2013; Baxter & Sagart, 2014).

Correspondences between Chinese onset voicing and SV tones are more controversial if we assume that PVM did not have contrastive onset voicing but rather had a register contrast carried over from Proto-Vietic, as I have argued in §7.2. If PVM had low and high registers, how did it borrow OC-EMC voiced and voiceless onsets in such a way that they later consistently developed the expected low-series tones (A2, B2, and C2) for etyma with OC-EMC voiced onsets and high-series tones (A1, B1, and C1) for etyma with OC-EMC voiceless onsets? In other words, OC-EMC voiced onsets must have been consistently borrowed with PVM low-register onsets, and similarly, OC-EMC voiceless onsets with PVM high-register onsets. These onset correspondences are not necessarily a problem. First, low-register onsets are frequently found to be pronounced with optional closure voicing, as in Mon (Haswell, 1901; Blagden, 1910; Shorto, 1962), Chrau (Tạ et al., 2022), Mnong Râlam (Brunelle et al., 2022b), Chru (Brunelle et al., 2020) and Southern Raglai (Brunelle et al., 2022a). PVM registers may have been produced with such an optional

voicing, leading PVM speakers to interpret OC-EMC voicing as register. Moreover, the OC-ECM onset voicing contrast likely conditioned modulations of f0, phonation, and vowel quality on the following vowel, like most voicing contrasts (cf. §2.1.3), and these coarticulatory modulations would have made it perceptually compatible with the PVM register contrast. Contemporary Raglai provides a useful illustration of such a situation. Northern Raglai preserves a voicing contrast in onset obstruents, while Southern Raglai has transphonologized it into a register contrast with almost no traces of closure voicing (Brunelle et al. 2022). Yet, the two varieties are in close contact and are almost perfectly mutually intelligible. Brunelle (p.c) reports that when native speakers are asked about differences between dialects, they mention vowel nasalization, aspiration and lexical items, but never mention voicing and register. It appears that Northern Raglai voicing and Southern Raglai register are perceptually equivalent.

7.3.2.2. Early Sino-Vietnamese (later stage)

There was an intermediate period between ESV and LSV when MC lost its *-h/s and thus developed a contrast between tone A (*pingsheng*) and tone C (*qusheng*), while PVM was still atonal. This period is estimated to have lasted between the 3rd and 6th century CE (Pulleyblank, 1973, 1978; Sagart, 1986; Zhu, 2015). During that period, all Chinese loans with open syllables, whether they bore MC tones A or C, were borrowed into Vietnamese with an open syllable and therefore later developed A tones, which is evidence that Vietnamese still had coda -h (Alves, 2018). Crucially, no MC words borrowed at that stage bear tone C *(hỏi/ngã)* in SV, supporting the claim that the PVM words that later developed tone C had a syllable profile (-h) that did not exist in MC. As for Chinese words that now have

shangsheng (tone B), they were borrowed into PVM with tone B (*sắc/nặng*), indicating that both MC and PVM probably preserved their final glottal stops (or a glottalization derived from it). Otherwise, MC is reconstructed with a voicing contrast in onsets, and the explanation proposed to account for correspondences between Chinese voicing and PVM register still applies at this stage.

As there is a large number of ESV items with C-to-A correspondences, including both lexical and grammatical items, Alves (2018) hypothesized that this stage must have lasted at least four centuries, suggesting that PVM would have preserved its laryngeal codas until the 8th CE century. If this is correct, PVM tonogenesis happened two centuries later than Haudricourt (1954b)'s figure of the 6th century CE.

7.3.2.3. Late Sino-Vietnamese

The loss of *-ʔ and the consequent formation of *shangsheng* (tone B) in MC is claimed to have happened around the 7th century CE, based on explicit descriptions of tones in written records (Pulleyblank, 1978; Sagart, 1986; Zhu, 2015; Alves, 2018). Tone correspondences in LSV (Chinese loans borrowed from the 10th-12th century) were therefore likely based on the tonal properties of Chinese loanwords. How were these properties reinterpreted in Sino-Vietnamese and how can they inform us on the phonetic realization of PVM syllable at that time?

Tone correspondences in LSV are not trivial: as can be seen in Figure 7-3, they are A-to-A, B-to-C, and C-to-B, suggesting that LMC tone B (*shangsheng*) was phonetically closer to Vietnamese tone C (*hỏi/ngã*) than Vietnamese tone B (*sắc/nặng*), while LMC tone C (*qusheng*) was phonetically closer to Vietnamese tone B than Vietnamese tone C.

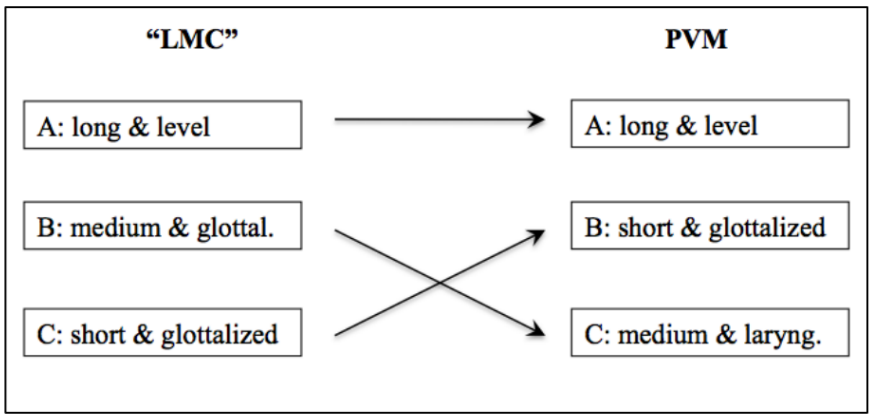


Figure 7-3. Phan's revision to Sagart's (1986) explanation of tonal patterns in Late Sino-Vietnamese

Sagart (1986) and Phan (2013) hypothesized that LMC loans were assigned LSV tones based on their duration. According to Sagart (1986), tone A was the longest in both MC and PVM, MC tone B and PVM tone C were intermediate in length, and MC tone C and PVM tone B were the shortest. The motivations for these reconstructions of the duration of tones are not clearly explained in Sagart (1986), but seem to be based on the shortening effect of a final glottal stop in B tones and on the presence of glottalized phonation in C tones in some modern Chinese dialects (Sagart did not clearly explain how glottalization makes the C tone shorter than other tones). Therefore, according to Sagart (1986) and Phan (2013), the three LMC and PVM tones were matched according to duration, leading to the tone patterns observed in LSV (Figure 7-3). Unfortunately, this explanation is not without problems. It first assumes a fairly categorical ternary length distinction that does not seem to be attested in contemporary tone languages. Secondly, recent results on cross-linguistic tone imitation and identification do not reveal a significant effect of duration patterns when speakers of tone languages have to produce or perceive the tones of another language (Chen, Best, & Antoniou, 2020; Tsukada, 2023). More generally, it is unclear why Sagart and Phan chose to rule out a possible effect of f0 in LSV tone

correspondences; they do recognize that phonation could be a secondary factor in tone matchings but do not elaborate on the issue.

Besides duration, what do we know about the phonetic realization of LMC tones? MC *shangsheng* (tone B) is usually reconstructed with a rising f0 and a final glottal closure (ʔ) that is still preserved in many Chinese dialects (Mei, 1970; Sagart, 1989). As for MC *qusheng* (tone C), it is reconstructed with creakiness (or laryngealization/glottalization in other researchers' terms) and with a lower or falling f0 contour (Mei, 1970; Pulleyblank, 1978; Sagart, 1986, 1989, 1999).

The shape of late PVM tones was probably rather different. I hypothesize that when LSV etyma were borrowed, tone C in PVM, whether it preserved its coda or not, had a high level or rising f0 contour, similar to that found in Rục and Arem (Chapters 4-5), rather than a falling contour as claimed in Haudricourt (1954b). It is also likely that tone B preserved some kind of final glottalization (possibly creakiness) left by former glottal stops and glottalized sonorant codas, as this final glottalization is still present in tone B2 in modern Northern Vietnamese and in numerous varieties of Central Vietnamese and Mường dialects. The f0 contour of tone B at that stage is difficult to determine, but its low falling shape in in Rục B2, in Arem syllables with -ʔ and glottalized sonorant codas, in Northern Vietnamese B2, and in all three North-Central Vietnamese dialects investigated in this study (Cổ Định, Nghi Ân, and Diêm Điền) is evidence that it was not necessarily rising as assumed by Haudricourt (1954b).

If this is correct, LMC *shangsheng* (tone B) would have been borrowed with PVM tone C based on its high (and possibly rising) f0, but also possibly because the final -ʔ of *shangsheng* was perceived as a laryngeal coda functionally assimilated with a surviving

PVM -h. Alternatively, PVM -h might have been weakened into some kind of glottal constriction, similar to that reconstructed in LMC *qusheng*, although the phonetic motivation for such a change is not obvious. LMC *qusheng* (tone C), on the other hand, would have been borrowed as PVM tone B because of their common final creakiness/glottalization (and possibly their low falling f0 contour).

In short, I propose that the basis for tone correspondences in LSV were the f0 height and contour, and final phonation of tones in MC and PVM, as shown in Figure 7-4. We may never know the exact phonetic details of tones in MC and PVM, but an explanation for LSV tone correspondences based on f0 and phonation has an advantage over the duration-based model proposed by Sagart (1986) and Phan (2013). This model does not presuppose that both MC and PVM had a marked three-way length contrast between tone categories, but instead resort to common phonetic properties of tones in ESEA and a broad typology of the effects of glottal codas in different languages.

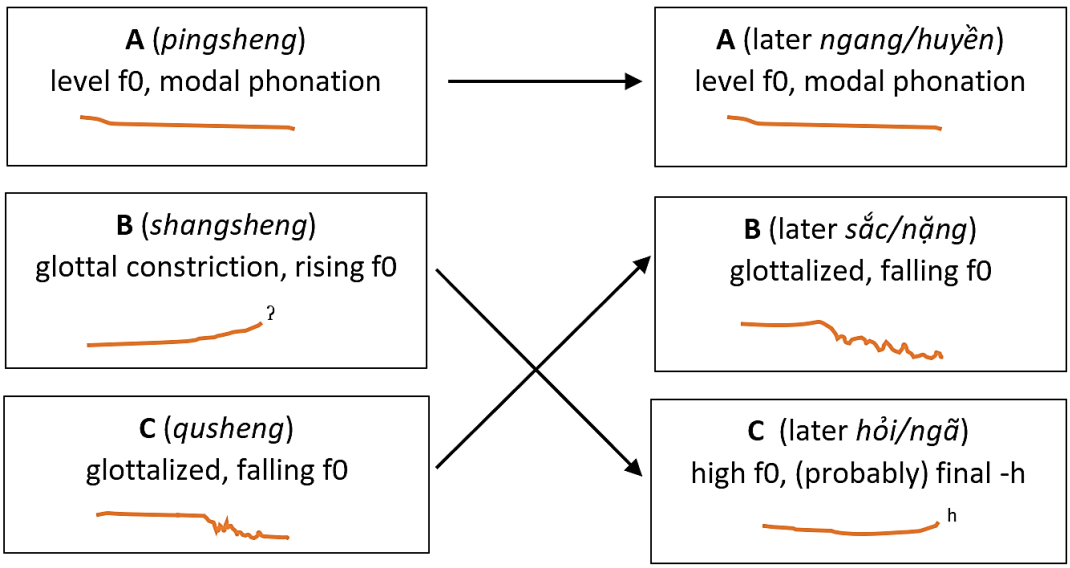


Figure 7-4. Reconstructions of the phonetic properties of Middle Chinese (left) and Proto-Việt-Mường (right) tones that might be the basis for tone matching (arrows).

A final point that is relevant to LSV tone correspondences is that they still worked by coda-derived tone pairs (A, B, C) rather than by individual tones (A1, A2, B1, B2, C1, C2). This suggests that the two members of each tone pair were still consistent in their phonetic profiles, despite the fact that PVM was probably always registral (§7.2.1) and that LMC had already lost voicing and developed register-like properties in the 8th – 9th century CE (Pulleyblank, 1978). There are two possible explanations for this state of affairs. The first one is that the two members of each tone pair maintained relatively similar tone contours because of the relatively recent loss of glottal codas in PVM and MC. However, the fact that Rục B1 and B2 have fairly different pitch contours, even if the language preserves relatively distinct cross-cutting register and tone categories, clearly indicates that this cannot be taken for granted. Perhaps it is more likely that LSV tone correspondences still largely relied on syllable-final phonation and that f0 contour remained secondary.

In any case, the reconstruction of a register in LMC around the 9th century CE due to onset devoicing (Pulleyblank, 1978) makes the correspondences between LMC and PVM onset-derived tone categories even more straightforward than at earlier stages, where OC and EMC were claimed to have an onset voicing contrast.

7.3.3 Tonogenesis in Proto-Việt-Mường and Vietnamese

Let us now turn to the timing of tonogenesis in Vietnamese to determine if tones developed independently in different branches of PVM (including Vietnamese or Vietnamese dialects), in PVM as a whole, or even higher up, in the Cuối-Việt subbranch (Figure 7-1).

Haudricourt (1954b) dated the beginning of tonogenesis from glottal codas in Vietnamese back to the 6th century and the process of onset devoicing to the 12th century,

but he did not justify these datings (I suspect that he assumed that Middle Chinese and Vietnamese underwent tonogenesis at the same time.). The SV data in the previous section supports the idea that PVM tonogenesis (from laryngeal codas) happened between the 8th – 12th century CE. However, it is still hard to restrict the time interval further and the probable sequence of tone development, i.e., whether tones B and C were formed first or developed at the same time, given the lack of sufficient direct evidence.

As mentioned above, tone correspondences in SV always work by tone pairs but not by specific tonemes, suggesting that members of each PVM tone category were largely similar in their phonetic profiles, f0 contour, final phonation, and duration, all being independent of their register-conditioned differences. However, it is undeniable from the tone systems of modern Vietnamese and Mường dialects that tones in each category started evolving differently and underwent different patterns of mergers after the LSV period (ca. 10th – ca. 12th century CE) (Ferlus, 1998b; Nguyễn, 2005; Nguyễn, 2009d). This is exemplified by the two North-Central Vietnamese dialects in which B2 and C2 merged without a parallel merger of B1 and C1, Cổ Định and Diêm Điền (Chapter 6).

A PVM tonogenesis around the 8th – 12th century CE coincides with an estimated split between Vietnamese and Mường, claimed to have happened at the soonest in the 7th – 8th century CE, based on lexicostatistics (Nguyễn, 1978; Nguyễn, 1995). More complicated scenarios for the break-up of PVM have also been proposed. Phan (2013) suggests that Mường dialects are not a unified subgroup but rather a number of different groups that branched out directly from PVM, alongside Vietnamese. Some Vietnamese authors go even further and propose that Vietnamese is not a unified group; according to them, Central and Southern Vietnamese would be daughters of PVM independent of Northern

Vietnamese but would have converged with the latter due to the centralizing impact of the Vietnamese state in the lowlands (Nguyễn, 1995; Nguyễn, 2009d). The linguistic evidence does not favour one of these scenarios over the others, but the fact that all Vietnamese and Mường varieties share the loss of both final laryngeals *-ʔ and *-h supports the idea that they would not have split before the end of the late Early Sino-Vietnamese stage in the 9th century (a little later than suggested by lexicostatistic evidence).

A possible problem with the scenario presented above is the nature of the tone system of Cuối. The conservative segmental structure of Cuối seems to indicate that it branched out from PVM relatively early (it preserves onset clusters, final -l and has less diphthongization (Hoành, Anh, Tuệ, & Alves, 2022)). However, Cuối dialects generally have six-tone systems in open syllables (Ferlus, 1998b), and some dialects exhibit tone mergers mirroring those found in different Vietnamese dialects: Thổ Làng Lỡ exhibits a C1/C2 merger like the Thanh Hoá dialect, and Cuối Tân Hợp seems to have B2/C2 merged like Nghệ Tĩnh dialects (Nguyễn & Nguyễn, 2019). The fact that all the languages of the Cuối-Việt branch have six-tone systems could be interpreted as evidence that tonogenesis occurred before PVM, but this is hard to reconcile with the SV tone correspondences presented above, as they support the presence of glottal codas as late as the 9th century. An alternative explanation is that Cuối, despite its apparently conservative segmental structure, split from PVM later than normally assumed and that Vietnamese and Mường underwent rapid segmental changes relatively recently (a scenario partly evidenced by a recent reinterpretation of early Nôm documents – texts written in Vietnamese with phonetically-adapted Chinese characters – by Shimizu (2020)). A promising way to explore this would be to systematically study Chinese loans in Cuối and Mường dialects to establish if they obey

the same tonal correspondences as Sino-Vietnamese.

Future studies also need to work on tone developments following tonogenesis (tone change) in Vietic languages and dialects. For example, one needs to explain how Vietnamese and Rục B1 and B2 got their opposite f0 contours if they originated from the same final codas *-ʔ, and how Vietnamese C1 and C2 got their falling-rising contour from a high level or rising f0 contour conditioned by *-h. There have recently been attempts at studying tone change in fully formed tone systems in ESEA languages (Pittayaporn, 2007, 2018; Yang & Xu, 2019; Yang, 2022), but these issues have barely been touched upon in Vietnamese phonetics. For example, the tone C1, as produced in Hanoi, has evolved from a falling-rising to a falling tone since the 1950s (Đoàn, 1977; Hoàng, 2004; Kirby, 2011; Brunelle, Hạ, & Grice, 2016), and the high rising tone B1 has developed a low falling-rising variant in young Northern Vietnamese speakers (Brunelle et al., 2016). The study of tone change will undoubtedly contribute to a better understanding of tone developments in general.

7.4 Concluding remarks

In this dissertation, I described the tonation systems of five Vietic varieties to exemplify the diverse tonation systems found in the Vietic family. I showed that these diverse systems result from the interaction between a register contrast reconstructed for Proto-Vietic and different patterns of preservation of glottal codas. Vietic proto-register was likely a typical Austroasiatic one, whose phonetic properties might have included differences in f0, phonation type, vowel quality, and consonantal properties such as redundant closure voicing and VOT.. This register contrast evolved differently in different languages and did

not leave many recognizable vowel quality and phonation traits in PVM. Tone (i.e., tone developing from laryngeal codas) was not yet present in Proto-Vietic but probably developed in PVM in the period between the 8th – 12th century CE. The dating of tonogenesis in other Vietic languages requires further study.

Results about the effects of final laryngeals on the phonetic properties of preceding vowels in Rục and Arem, supported by recent experimental results obtained from other languages, also shed new light on correspondences between Chinese and Vietnamese tones in different layers of the Sino-Vietnamese lexicon, Chinese loanwords in Vietnamese. These findings suggest that the effects of laryngeal codas on f0 and phonation should be considered from both language-specific and typological perspectives when studying tonogenesis in different languages.

Concerning Vietnamese specifically, I put forward substantial changes to the classical hypothesis on tonogenesis by Haudricourt (1954b). I propose that tonogenesis from codas likely happened between the 8th and 12th century CE and would have created three tone categories in open syllables differentiated by their f0 height and contour, final phonation, and duration. These three tones crosscut PVM's f0-based register contrast to yield a total of six tones in open syllables. I argue that Vietnamese followed a tonogenetic path in which 2 registers underwent a three-way split yielding 6 tones, instead of 3 original tones undergoing a two-way split, in agreement with Gregerson and Thomas (1976); Gehrmann (2022). Later tone changes and different patterns of tone merger led to diverse tone systems in Vietnamese dialects, as exemplified by the three North-Central Vietnamese dialects studied in Chapter 6.

The proposals made in this dissertation could be dramatically enriched (and may

have to be revised) by instrumental investigation of tonation systems of other Vietic languages and dialects, such as Thavung, Maleng, Pọong, and Cuối. Systematic descriptions of these systems will help us better understand the phonetic underpinnings of tonogenesis and registrogenesis, especially in languages that are typologically similar to those studied here, open the door to the study of post-tonogenetic tone and register developments, refine the reconstruction of tonation in different branches of Proto-Vietic, and improve the internal classification of the language family.

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APPENDICES

Appendix 4-1. Wordlist designed to investigate the register contrast in Arem. Target syllables are in bold. Words with aspirated and implosive onsets, and with other vowels (shaded rows) were excluded from the final analysis as they are not vowel- and onset-balanced.

IPA	*English*	*Vietnamese*	*IPA*	*English*	*Vietnamese*
arɑ: **tɪ**:	*water turtles*	rùa nước	tì:	*to walk*	đi
daw tu: ulʊk	*to carry on head*	đội	atù:l	*to call someone*	gọi
tɛ:w	*swords*	gươm	cè:	*tea*	chè
mɨ:k **tɔ:ŋ**	*soot*	đan chiếu	tùəj	*tail*	đuôi
ta:ɲ ilìə	*knitting (mat)*	nhọ nồi	arìɲ **tɛ̀ŋ**	*crossbow rope*	dây nỏ
uki:ɲ	*elbow*	cùi chỏ	ukì:n	*neck*	cổ
kʊ:lˀ atak	*to dig*	đào bới	kù:l	*name*	tên
kɛ:wˀ	*peacock*	công	mè:	*seasame*	vừng mè
ukɔ:p tʰɪ:	*wrist*	cổ tay	kùət	*frogs*	ếch
ʔan **ka:j** amɨh	*things*	cái	**kɛ̀:w** bit	*to rake (grass)*	cào cỏ
klɪ: kwɪ:	*bee venom*	nọc ong	umɔ̀: **lì:n**	*asshole*	lỗ đít
ulʊ:lˀ	*eggs*	trứng	kat **alù:ɲ**	*bald*	hói
kalɛ:	*chopsticks*	đũa	**lelè**: lìəh	*putting the tongue out*	lè lưỡi
ulɔ:ˀ	*old*	cũ	lùəm	*liver*	gan
ala:j	*lazy*	lười	**lɛ̀:j** kɨj	*now*	bây giờ
ⁿrɪ:	*pestle*	chày	cirang **cirì**:	*banyan trees*	cây đa
acə:ŋ **rʊ:t**	*cramping*	chuột rút	cirù:	*deep water*	nước sâu
mè:w ʔa: **cirɛ:w**	*meowing*	mèo kêu	mè:w	*cat*	mèo
rə:j	*whip*	cái roi	urùəj	*flies*	ruồi
sìəŋ **ⁿra:ɲ**	*ribs*	xương sườn	cirɛ̀ŋ **rɛ̀:n**	*hole-making sticks*	gậy chọc lỗ
dɨ:p	*stick rice*	gạo nếp	___	___	___
ɗʊ:j mù:c mɛ̀t	*blind (one eye)*	đui	mɨ:k **ɗùh**	*mountain climbing*	leo núi
ɗɔ:ŋ	*floating*	nổi	___	___	___
___	___	___	kɑ:n **ɗùəj**	*youngest child*	con út
ciɗa:	*guava*	ổi	**ɗɛ̀m** kɑ:nˀ	*shallow water*	nước cạn
tʰæ:n	*cigarette*	điếu thuốc	tʰì:t	*meat*	thịt
tʰʊ:n	*year*	năm	**tʰɛ̀:l** karæ:ŋ	*to bask*	phơi nắng
tʰa:j	*ears*	tai	kʰɛ:	*stream*	suối
tʰɔ:ˀ dæ:k	*to pour (water)*	rót nước	kùəc **kʰan**	*blanket*	đắp chăn
utʰɑ:l pò:	*corn cob*	lõi ngô	kʰɑ:ˀ	*difficult, hard*	khó
kʰæ:t	*thirsty*	khát	___	___	___
tæ:l næ:ˀ	*crossbow*	báng nỏ	**aɗæ:lˀ** tʰɪ:	*to reach hands out*	chìa tay
lakæ:	*chicken*	gà	karæ:	*river monkey*	khỉ sông
kʊ:ˀ **læ:ŋ**	*sweet potato*	khoai lang	ɗɑ:	*full of food*	no
tɑ:	*to measure*	đo	palɑ:j	*earings*	hoa tai
ci:q	*head louse*	chấy	cì:q	*sister*	chị
mi:	*you*	mi, mày	___	___	___

Appendix 4-2. Wordlist designed to investigate effects of different codas in Arem. Target syllables are in bold.

IPA	*English*	*Vietnamese*	*IPA*	*English*	*Vietnamese*
kaciə	*gun powder*	thuốc súng	tapìə	*to level*	san bằng
aliəh ulè:ʔ	*to pick fruits*	hái, bứt trái	lìəh	*tongue*	lưỡi
aniəʔ	*cork*	nứa	pìəʔ	*father*	cha
atʰiəl	*fin*	vảy cá	lakæ: **isìəl**	*chicken digging*	gà bới
pɪh **akiəlʔ**	*to lie on side*	nằm nghiêng	kadɑ:j **patìəlʔ**	*middle finger*	ngón giữa
___	___	___	ᵐbùə	*mortar*	cối giã gạo
uʔuəh lanæ:ʔ	*to work*	làm việc	**pùəh** ʔɛ:wʔ	*to wash clothes*	giặt quần áo
ɓuəʔ	*hammer*	búa	pùəʔ	*uncle*	chú
paduəl rì:w	*roof*	nóc nhà	taŋùəl	*gaur*	bò tót
lakuəlʔ| lakulʔ	*knee*	đầu gối	ŋùəlʔ	*to swim*	bơi
ᵐpɪ:	*chilli*	ớt	lapì:	*worm*	sâu
pɪh	*to sleep*	ngủ	mawʔ **pìh**	*poisonous sap*	nhựa độc
cɪ:ʔ	*head louse*	chấy	cì:ʔ	*sister*	chị
cɪ:l tʰɪ:	*palm*	lòng bàn tay	cì:l	*lemongrass*	sả chanh
ciɓɪlʔ	*vivid*	chói	___	___	___
mʊ:	*to buy*	mua	mù:	*season*	mùa
udʊh	*navel*	cái rốn	mɨ:k **dùh**	*to hike*	lên núi
kʊ:ʔ	*tuber*	củ	kù:ʔ	*mother's younger brother*	cậu
apʊ:l	*lime*	vôi	kù:l	*name*	tên
kʊ:lʔ atak	*to dig*	bới, bươi đất	kù:lʔ	*pig*	lợn
cida:	*guava*	ổi	___	___	___
abah	*to vomit*	nôn mửa	tì: **vèh**	*to fish*	đi câu
na:ʔ	*3rd sg.*	nó	ⁿlèl	*smooth*	trơn nhẵn
pal	*to fly*	bay	talèlʔ	*chin*	cằm
palʔ bʌjʔ	*to set trap*	đặt bẫy	___	___	___
dɑ:	*full*	no	**ᵐbì**: arìŋ	*to braide rope*	bện dây
abɑh	*door*	cửa	amìh	*what?*	cái gì
dɑ:ʔ	*wild banana*	chuối rừng	ᵐpɨ:ʔ	*daughter in-law*	con dâu
sɑ:l tɛ:w	*scabbard*	bao gươm	jɨ:l	*cloud*	mây
karɑ:lʔ	*wolf*	chó sói	jɨlʔ	*to wake up*	thức dậy
kade:	*deer*	hươu	mè:	*sesame*	mè, vừng
kɛh kənɛh	*to make fire*	đánh lửa	mèh	*cold*	lạnh rét
ule:ʔ	*fruit*	trái	zè:ʔ	*cheap*	rẻ tiền
lapʌ:	*basket*	thúng, rổ	dɔ:	*wine*	rượu
pʌh	*seven*	bảy	kɔh	*to chop*	chặt
ɲʌ:ʔ	*to miss someone*	nhớ	ᵑkɔ:ʔ	*rice*	gạo
so:	*straw*	rơm	pò:	*corn*	ngô
utʰɪŋʔ **toh**	*(snake) bite*	rắn cắn	**pòh** abɑh	*to open door*	mở cửa
do:ʔ	*bean*	đỗ	___	___	___
kalɛ:	*chopsticks*	đũa	tanʉ:	*angry*	giận
pɛh ulè:	*to prune*	ngắt tỉa	ala:j **alu:ʔ**	*lazy*	lười biếng
lakæ:	*chicken*	gà	**tæ:l** næ:ʔ	*crossbow body*	thân nỏ, báng
akæ:ʔ	*fish*	cá	atæ:lʔ	*testicles*	hòn dái

Appendix 4-3. Wordlist designed to investigate the contrast between plain and glottalized nasal codas in Arem.

IPA	*English*	*Vietnamese*	*IPA*	*English*	*Vietnamese*
ⁿcaŋ **kʰiəŋ**	*burning coal*	than hồng	katìəŋ	*chest*	ngực
liəŋˀ	*to hover*	liệng	mìəŋˀ	*stepfather*	dượng
ɲuən	*hare*	thỏ rừng	cùəŋ	*axe*	rìu
ᵑ**kuəŋˀ** ulæːˀ	*petiole*	cuống lá	___	___	___
tɪːn	*to believe*	tin	ukìːn	*neck*	cổ
cɪːnˀ	*cooked*	chín	**kìːnˀ** dæːk	*to get water*	kín nước
takʉŋ	*heel*	cựa gà	icɪːm **vìːŋ**	*swallows*	chim én
latʉŋˀ	*wood wall*	phên vách	ŋkìːŋˀ	*eggplants*	cà tím
tʰʊːn tiəm	*two years ago*	năm kia	nùːn	*mother*	mẹ
ʔʊːmˀ	*to shower*	tắm	lùːnˀ	*to enter*	vào
toːŋ dæːk	*water source*	nguồn nước	acòŋ	*shrimp*	tôm
ᵑ**koːŋˀ** mùh	*bridge of nose*	sống mũi	ròŋˀ	*back*	lưng
tʃɛːɲ	*green*	màu xanh	mèt **karæːŋ**	*sun*	mặt trời
mùːc **mɛːɲˀ**	*a piece*	một miếng	ᵐpæːŋˀ	*to throw*	ném, quăng
dɔːŋ	*floating*	nổi	**bɑːŋ** kùːlˀ	*pig trough*	máng lợn
tʃɔːŋˀ ɲùːɲˀ	*bridge of knife*	cái sống dao	**kɑːŋˀ** næːˀ	*crossbow wings*	cánh nỏ
kʰan	*blanket*	chăn	apèn	*skirts*	váy
tʰanˀ	*hard*	cứng	mènˀ	*salty*	mặn
ləːŋ	*tall*	cao	acʌːŋˀ	*mouse*	chuột

Appendix 5-1. Rục wordlist: the first wordlist, recorded in July 2019. Syllables that usually pair with the target syllable are parenthesized.

	Rục (IPA)	English	Vietnamese		Rục (IPA)	English	Vietnamese
1	ti:n A1	*talk*	nói chuyện	34	lɔ: B2	*peel*	gọt vỏ
2	ti: A2	*go*	đi	35	la:ŋ A1	*sweet potato*	khoai lang
3	ti: B1	*pee*	đái	36	la: A2	*spleen*	lá lách
4	tiek B2	*dumb*	điếc	37	la:j B1	*fish net*	lưới cá
5	tɛ:n A1	*black*	màu đen	38	la:ŋ B2	*ounce*	lạng
6	tɛ:n A2	*lighter*	đèn	39	ki:m A1	*needle*	kim
7	tɛ: B1	*you*	mày	40	təki: A2	*neck*	cổ
8	tɛ:w B2	*wood chipping*	đục đẽo	41	(acɔ: B1) ki: B1	*bitch*	chó cái
9	tu:h A1	*poor*	nghèo	42	kɛ:ŋ A1	*soup*	canh
10	tu:j A2	*mad*	điên	43	(tɔk) kɛ: B1	*gecko*	tắc kè
11	kətu:m B1	*interlink*	buộc lại	44	kɛ: B2 (ho: A1)	*mine*	của tôi
12	tu: B2	*intercourse*	giao hợp	45	(ku: A2) ku: A1	*cuckoo*	chim cu
13	tɔ: A1	*measure*	đo đạc	46	ku:l A2 (cali: A1)	*corn cob*	lõi ngô
14	tɔ:j A2	*require*	đòi hỏi	47	(tu:ɲ A2) ku:l B1	*dig up*	bới
15	tɔ:n B1	*pick up*	đón	48	ku:l B2	*pig*	lợn
16	tɔ:j B2	*garlic*	tỏi	49	kɔ:n A1 (ka: A1)	*clf.*	con (gà)
17	ta: A1	*grandpa*	ông ngoại	50	(kɔ:n A1) kɔ: A2	*stork*	con cò
18	(ngaj A1) ta ta: A2	*now*	ngay bây giờ	51	kɔ: B1	*have*	có
19	(la) ta: B1	*rock*	đá	52	kɔ:k B2	*stake*	cái cọc
20	tata: B2 [ta: B2, nta: B2, lta: B2]	*ladder*	thang	53	kaka:l A1	*scratch*	gãi
21	ali:ŋ A1	*above*	ở trên	54	ka:l A2	*locking doors*	cài cửa
22	cəli:ŋ A2	*stick*	gậy	55	ka: B1	*fish*	cá
23	puli: B1 (pli: B1)	*fruits*	trái cây	56	ka:l B2	*kale*	rau cải
24	li: B2 (maki: B1)	*marry*	lấy vợ	57	taŋ A1	*in progress*	đang
25	kəlɛ: A1	*ankle*	mắt cá chân	58	ta:ŋ A2	*road*	đường
26	lɛ:h A2	*roots*	rễ cây	59	ta:h C1	*unsalted*	nhạt
27	(k)lɛ:ŋ B2	*animals' ankle*	cẳng thú	60	ta:h C2	*recover*	khỏe ốm
28	pulu: A1	*thigh*	đùi	61	pa:h C1 (si: A1)	*clap*	vỗ tay
29	lu:ŋ A2	*pregnant*	có thai	62	kupa:h C2	*broken*	vỡ
30	təlu:l B1	*eggs*	trứng	63	pa:n B1	*sell*	bán
31	lu:t B2	*flood*	bão lụt	64	pa:n B2	*friend*	bạn
32	lɔ: A1	*worry*	lo lắng	65	tap B1	*dam*	đắp
33	alɔ: B1	*paddy*	lúa	66	tap B2	*kick*	đạp

Appendix 5-2. Rục wordlist: the second wordlist, recorded in October 2021.

	Rục (IPA)	English	Vietnamese		Rục (IPA)	English	Vietnamese
1	pulih^{C1}	*appease*	dỗ dành	26	təpɛ^{A2}	*raft*	cái bè
2	kalih^{C1}	*rat*	chuột nhắt	27	ɗɛ ɗɛ^{B1}	*speaking softly*	nói nhỏ
3	mi^{A1}	*you*	mày	28	kɛ^{B1}	*gecko*	tắc kè
4	cali^{A1}	*corn*	ngô	29	mɛ^{B2}	*mother*	mẹ
5	təki^{A2}	*neck*	cổ	30	ɗɛ^{B2}	*cracks*	nẻ
6	ti^{A2}	*go*	đi	31	kɔh^{C1}	*grass*	cỏ
7	ki^{B1}	*female animal*	(con) cái	32	pakɔh^{C2}	*daytime*	ban ngày
8	ci^{B1}	*louse*	chấy	33	tɔ^{A1}	*measure*	đo
9	ci^{B2}	*sister*	chị	34	ɗɔ^{A1}	*full*	no
10	li^{B2}	*take*	lấy	35	ɓɔ^{A2}	*oxes*	con bò
11	kəduh^{C1}	*tree bark*	vỏ cây	36	mɔ^{A2}	*crawl*	bò
12	truh^{C2}	*deep*	sâu	37	lɔ^{B1}	*paddy*	lúa
13	pahu^{A1}	*sweat*	mồ hôi	38	raʃɔ^{B1}	*give birth*	đẻ
14	ŋu^{A1}	*stupid*	ngu ngốc	39	hɔ^{B2}	*relatives*	họ hàng
15	mu^{A2}	*season*	mùa	40	lɔ^{B2}	*peel*	bóc vỏ
16	lapu^{A2}	*gourd*	bầu	41	trah^{C2}	*middle*	giữa
17	bru^{B1}	*forest*	rừng	42	ʃah^{C1}	*tear apart*	xé
18	cu^{B1}	*grandchildren*	cháu	43	ta^{A1}	*grandpa*	ông ngoại
19	cu cu^{B2}	*grasshopper*	châu chấu	44	pa^{A1}	*three*	số ba
20	ŋu^{B2}	*drink*	uống	45	la^{A2}	*spleen*	lá lách
21	pɛh^{C1}	*break*	bẻ	46	kuma^{A2}	*rain*	mưa
22	cɛh^{C1}	*split*	chẻ	47	tata^{B1}	*rock*	đá
23	klɛ^{A1}	*ankle*	cổ chân	48	la^{B1}	*leave*	lá
24	kalɛ^{A1}	*chopsticks*	đũa	49	ka^{B2}	*look up*	ngước
25	ɗɛ^{A2}	*press down*	đè xuống	50	ŋa^{B2}	*lay up*	ngửa

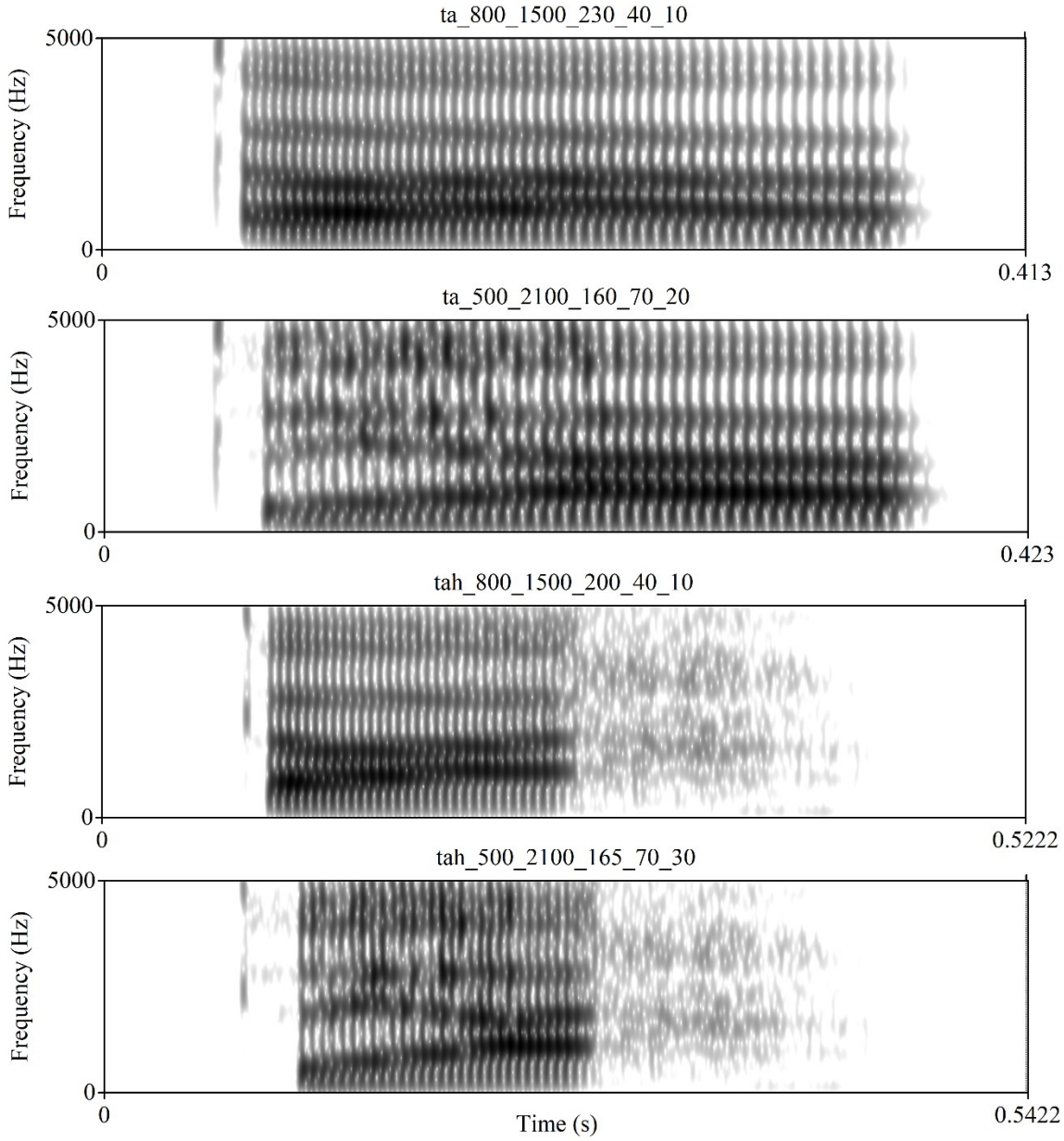
Appendix 5-3. Rục wordlist: the third wordlist, recorded in October 2021, after the perception task.

	Rục (IPA)	English	Vietnamese		Rục (IPA)	English	Vietnamese
1	ta^{A1}	*grandfather*	ông ngoại	5	la^{A2}	*spleen*	lá lách
2	ta^{A2}	*right now*	bây giờ	6	kəla^{A2}	*animal corp*	xác thú
3	tah^{C1}	*unsalted*	nhạt	7	pah^{C1}	*applause*	vỗ tay
4	tah^{C2}	*recover*	khoẻ lại	8	kupah^{C2}	*broken*	vỡ

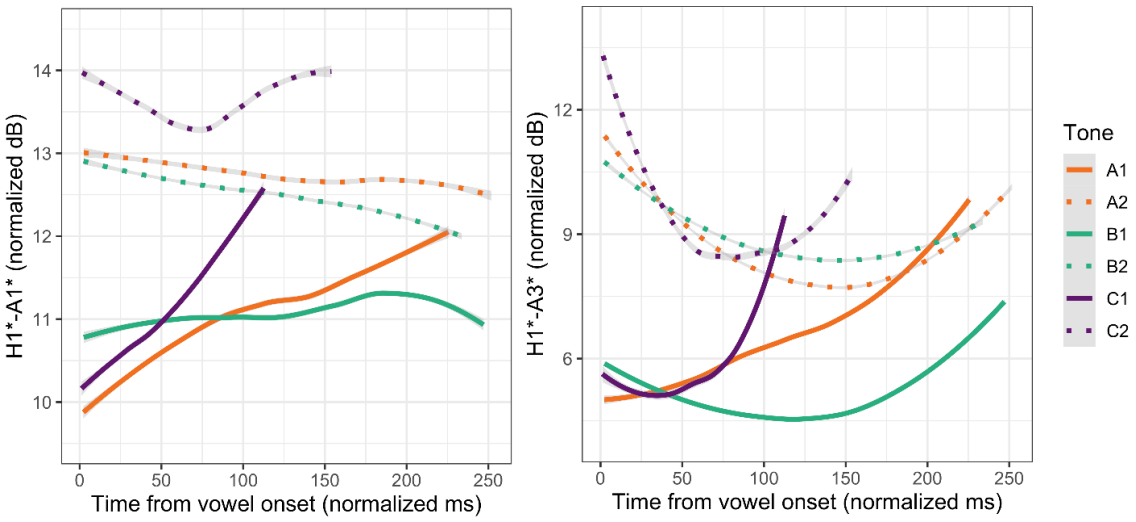
Appendix 5-4. The number of pre-voicing tokens by *speaker* and *word*.

	F03_2019	F05_2021	F07_2021	F08_2019	F09_2019	F10_2021	F12_2021	F13_2021	F16_2021	F18_2021	M05_2019	M06_2019	M08_2019	M09_2019	M12_2021	M20_2021	Total
kɛː B2	2				1							1	1	1			**6**
təkiː A2						2							1		1		**4**
kiː B1						1			1							1	**3**
kiːm A1												1					**1**
kɔːn A1	2			1							1	1		3			**8**
kuː A1													1				**1**
kuːl B1				1								1					**2**
kətuːm B1													3				**3**
lapuː A2		4	4				3	4	3							4	**22**
paː A1										1						1	**2**
pah C1												1					**1**
paːn B1												1					**1**
pɛː A2																1	**1**
pɛh C1																1	**1**
taŋ A1												1	3				**4**
taː A1																1	**1**
taː B2																1	**1**
tah C2													1				**1**
tɛːn A2													1				**1**
tiː B1													1				**1**
tɔː A1													1			1	**1**
tɔːj B2												1	2				**1**
tɔːn B1													1				**3**
Total	**4**	**4**	**4**	**2**	**1**	**3**	**3**	**4**	**4**	**1**	**1**	**8**	**16**	**4**	**1**	**11**	**71**

Appendix 5-5. Spectrogram of four synthesized stimuli most typical to A1, A2, C1, and C2 tones. The numbers in the stimuli names on the top of each spectrogram represent the synthesized phonetic values, F1, F2, f0, open quotient, and VOT, respectively.



Appendix 5-6. H1*-A1* (left) and H1*-A3* of Rục six tones.



Appendix 6-1. Wordlist designed to compare vowels between the standard Northern dialect and North-Central Vietnamese dialects. This list includes 313 lexical items. Items with both French and English glosses have data from other Vietic languages in the appendix for vowel systems in Vietic languages.

	Gloss	*Standard orthography*	*Hà Nội*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
1	*pieces*	mảnh	mɛŋ^{C1}	mɛŋ^{C1}	miŋ^{B1}	mɛŋ^{B2}
2	*conduite, tuyau, conduit, pipe*	máng	ma:ŋ^{B1}	miəŋ^{B1}	m^{w}a:ŋ^{B1}	ma:ŋ^{B1}
3	*young girl*	nàng	na:ŋ^{A2}	na:ŋ^{A2}	n^{w}a:ŋ^{A2}	na:ŋ^{A2}
4	*to ask, beg*	nài	na:j^{A2}	na:j^{A2}	n^{w}a:j^{A2}	nan^{A1}
5	*turn around*	xoay	s^{w}aj^{A1}	s^{w}aj^{A1}	s^{w}a:j^{A1}	s^{w}aj^{A1}
6	*carry on two shoulders*	gánh	ɣɛŋ^{B1}	ɣɛŋ^{B1}	ɣɛŋ^{B1}	ɣɛŋ^{B1}
7	*closing doors*	gài	ɣa:j^{A2}	ka:j^{A2}	mon^{c1}	ɗɔŋ^{B1}
8	*sable, sand*	cát	ka:t^{D1}	ka:t^{D1}	k^{w}a:j^{A2}	ka:t^{D1}
9	*gratter, to scratch*	gãi	ɣa:j^{C2}	xa:n^{C2}	xot^{D1}	ɣa:j^{B2}
10	*retourner, revenir|return*	quành	k^{w}ɛŋ^{A2}	k^{w}aj^{A1}	kuə^{A1}	k^{w}aj^{A1}
11	*scrotum, scrotum*	dái	za:j^{B1}	ɗa:n^{B1}	z^{w}a:j^{B1}	za:j^{B1}
12	*fourreau, sheath*	bao	ɓa:w^{A1}	ɓəj^{A2}	[bôu]	ɓa:w^{A1}
13	*skinny*	gầy	ɣəj^{A2}	ɣaj^{A2}	ɣaj^{A2}	ʔom^{B1}
14	*disarray*	nhau	ɲaw^{A1}	ɲa:w^{A1}	ɲɑ:w^{A1}	ɲaw^{A1}
15	*emprunter, to borrow*	mượn	miən^{B2}	miən^{B2}		ma:n^{B2}
16	*to ride horse*	cưỡi	kiəj^{C2}	kə:j^{C1}	ɣɔm^{A1}	kə:j^{B2}
17	*griller (sur la braise), to roast (on embers)*	nướng	niəŋ^{B1}	na:ŋ^{B1}	n^{w}a:ŋ^{B1}	niəŋ^{B1}
18	*côtes charpente, ribs, frame*	sườn	siən^{A2}	siən^{A2}	siən^{A2}	t^{h}iən^{A2}
19	in progress	đương	ɗiəŋ^{A1}	ɗa:ŋ^{A1}	ɗ^{w}a:ŋ^{A1}	ɗa:ŋ^{A1}
20	*road*	đường	ɗiəŋ^{A2}	ɗa:ŋ^{A2}	ɗ^{w}a:ŋ^{A2}	ɗiəŋ^{A2}
21	fire	lửa	liə^{C1}	la^{C1}	l^{w}a^{B1}	liə^{B2}
22	fishnet	lưới	liəj^{B1}	lij^{B1}	l^{w}a:j^{B1}	liəj^{B1}
23	*bambou mince (Thyrsostachys siam), thin bamboo (Thyrsostachys siam)*	nứa	niə^{B1}	na^{B1}	n^{w}a^{B1}	niə^{B1}
24	*eau, water*	nước	niək^{D1}	na:k^{D1}	n^{w}a:k^{D1}	niək^{D1}
25	*itchy*	ngứa	ŋiə^{B1}	ŋiə^{B1}	ŋ^{w}a^{B1}	ŋiə^{B1}
26	*(couché) sur le dos, (to lie) on the back*	ngửa	ŋiə^{C1}	ŋa^{C1}	ŋ^{w}a^{B1}	ŋiə^{B2}
27	*ritual flags*	phướn	fiən^{B1}	fa:n^{A1}	fiən^{B1}	fiən^{B1}
28	*langue, tongue*	lưỡi	liəj^{C2}	la:n^{C1}	l^{w}aj^{B2}	niəj^{B2}
29	*personne, people*	người	ŋiəj^{A2}	ŋiəj^{A2}	ŋɑj^{A2}	ŋiəj^{A2}
30	*long*	trường	tɕiəŋ^{A2}	tɕiəŋ^{A2}	tɕiəŋ^{A2}	tiəŋ^{A2}

	Gloss	*Standard orthography*	*Hà Nội*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
31	*vomir, to vomit*	mửa	miə^{C1}	ma^{C1}	miə^{B1}	miə^{B2}
32	*alcool, alcohol*	rượu	ziəw^{B2}	ziəw^{B2}	ziəw^{B2}	ziəw^{B2}
33	*lait, milk*	sữa	siə^{C2}	siə^{C2}	siə^{C2}	tʰiə^{B2}
34	*pluie, rain*	mưa	miə^{A1}	mi^{A1}	miə^{A1}	miə^{A1}
35	*coupe-coupe, bush-knife*	rựa	ziə^{B2}	ziə^{B2}	zʷa^{B2}	ziə^{B2}
36	*fendre (du bois), to split (wood)*	bửa	ɓiə^{C1}	ɓiə^{C1}	ɓiə^{B1}	ɓiə^{B2}
37	*os, bone*	xương	siəŋ^{A1}	siəŋ^{A1}	siəŋ^{A1}	saːŋ^{A1}
38	*house level*	tầng	təŋ^{A2}	təŋ^{A2}	təŋ^{A2}	təŋ^{A2}
39	*fainted*	ngất	ŋət^{D1}	ŋət^{D1}	ŋat^{D1}	ŋət^{D1}
40	pull fishing rod	giật	zət^{D2}	zət^{D2}	ɓit^{D1}	zət^{D2}
41	*heurter, to bump*	vấp	vəp^{D1}	ɓəp^{D1}	ŋo^{A1}	ɓəp^{D1}
42	*door sill*	bậu	ɓəw^{B2}	ɓəw^{B2}	tɛʷa^{A1}	ŋɛk^{D2}
43	*se fâcher, to get angry*	giận	zən^{B2}	ɓəːt^{D1}	zan^{B2}	ɓaːj^{B2}
44	*dầy cake*	dầy	zəj^{A2}	zəj^{A2}	zaːj^{A2}	zəj^{A2}
45	*tamis, tamiser, sieve, sift*	rây	zəj^{A1}	zəj^{A1}	zəj^{A1}	zəj^{A1}
46	*rotin, rattan*	mây	məj^{A1}	məj^{A1}	məj^{A1}	məj^{A1}
47	*roseau, reed*	sậy	səj^{B2}	saj^{B2}	saj^{B2}	səj^{B2}
48	*sécher au feu, to dry on fire*	sấy	səj^{B1}	səj^{B1}	səj^{B1}	səj^{B1}
49	*traces, empreinte, trace, footprint*	dấu	zəw^{B1}	zəw^{B1}	zəw^{B1}	zəw^{B1}
50	*crocodile, crocodile*	sấu	səw^{B1}	səw^{B1}	səw^{B1}	tʰəw^{B1}
51	*sauterelle, grasshopper*	chấu	tɕəw^{B1}	tɕəw^{B1}	tɕəw^{B1}	tɕəw^{B1}
52	*long time*	lâu	ləw^{A1}	ləw^{A1}	ləw^{A1}	nəw^{A1}
53	*barbe, moustache, beard, moustache*	râu	zəw^{A1}	zəw^{A1}	zəw^{A1}	zəw^{A1}
54	*fiel, gall*	mật	mət^{D2}	mət^{D2}	mat^{D2}	mət^{D2}
55	*pou de corps, body louse*	rận	zən^{B2}	zən^{B2}	zan^{B2}	zən^{B2}
56	*penché en avant baisser la tête, lean forward, head down*	sấp	səp^{D1}	səp^{D1}	səp^{D1}	ʔup^{D1}
57	*short (not long/tall)*	thấp	tʰəp^{D1}	tʰəp^{D1}	tʰəp^{D1}	tʰəp^{D1}
58	*vinaigre, vinegar*	giấm	zəm^{B1}	zəm^{B1}	zəm^{B1}	zəm^{B1}
59	*cut and put branches into soild*	giâm	zəm^{A1}	zəm^{A1}	zəm^{A1}	zəm^{A1}
60	*huile, oil*	dầu	zəw^{A2}	zaw^{A2}	zaw^{A2}	zəw^{A2}
61	*arbre, tree*	cây	kəj^{A1}	kən^{A1}	kəːn^{A1}	kəj^{A1}
62	*clasifier for hero*	đấng	ɗəŋ^{B1}	ɗəŋ^{B1}	ɗəŋ^{B1}	ɗəŋ^{B1}
63	Momordica cochinchinensis	gấc	ɣək^{D1}	ɣək^{D1}	ɣək^{D1}	ɣək^{D1}
64	*raise head up*	ngẩng	ŋəŋ^{C1}	ŋəŋ^{C1}	ŋəŋ^{B1}	ŋəŋ^{B2}
65	*insecte, insect*	sâu	səw^{A1}	səw^{A1}	səw^{A1}	tʰəw^{A1}

	Gloss	*Standard orthography*	*Hà Nội*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
66	*ooccur, happen*	xảy	saj^{C1}	saj^{C1}	səj^{C1}	səj^{B2}
67	*shield*	chắn	tɕan^{B1}	tɕən^{B1}	tɕaːn^{B1}	tɕan^{B1}
68	astound	hửng	hɨŋ^{C1}	həŋ^{C1}	hɨŋ^{B1}	
69	*gulp*	chửng	tɕɨŋ^{C1}	liŋ^{C1}	loːŋ^{B1}	tɕɨŋ^{B2}
70	*gingembre, ginger*	gừng	ɣɨŋ^{A2}	ɣəŋ^{A2}	ɣəŋ^{A2}	ɣəŋ^{A2}
71	*grasp something falling*	hứng	hɨŋ^{B1}	həŋ^{B1}	hɨŋ^{B1}	hɨŋ^{B1}
72	*sunny after a rain*	hửng	hɨŋ^{C1}	həŋ^{C1}	həːŋ^{B1}	hɨŋ^{B2}
73	*rửng mỡ*	rửng	zɨŋ^{C1}	zək^{D2}	zɨk^{D2}	
74	*oeuf, egg*	trứng	tɕɨŋ^{B1}	tɕəŋ^{B1}	tɕəːŋ^{B1}	tɨŋ^{B1}
75	*content, happy*	mừng	mɨŋ^{A2}	məŋ^{A2}	məŋ^{A2}	mɨŋ^{A2}
76	*flaming*	phừng	fɨŋ^{A2}	fəŋ^{A2}	fəŋ^{A2}	fɨŋ^{A2}
77	*sésame, sesame*	vừng	vɨŋ^{A2}	vəŋ^{A2}	vɨŋ^{A1}	mɛ^{A2}
78	*celebrate*	mừng	mɨŋ^{A2}	məŋ^{A2}	maːŋ^{A2}	mɨŋ^{A2}
79	*abyss abyss*	vực	vɨk^{D2}	vək^{D2}	vək^{D2}	vɨk^{D2}
80	*construire dresser, build, develop*	dựng	zɨŋ^{B2}	zəŋ^{B2}	zəŋ^{B2}	zɨŋ^{B2}
81	*forêt, forest*	rừng	zɨŋ^{A2}	zəŋ^{A2}	zɨŋ^{A2}	zɨŋ^{A2}
82	*enflé, swollen*	sưng	sɨŋ^{A1}	kəŋ^{B1}	sɨŋ^{A1}	kaj^{B2}
83	*corne, horn*	sừng	sɨŋ^{A2}	səŋ^{A2}	səŋ^{A2}	tʰɨŋ^{A2}
84	*carry big round things with two hands*	bưng	ɓɨŋ^{A1}	ɓəːŋ^{A1}	ɓəːŋ^{A1}	ɓɨŋ^{A1}
85	*moving trees to other places*	bứng	ɓɨŋ^{B1}	ɓəŋ^{B1}	ɓɨŋ^{B1}	ɓɨŋ^{B1}
86	*staircase*	bực	ɓɨk^{D2}	ɓək^{D2}	ɓək^{D2}	ɓək^{D2}
87	*plucking*	gẩy	ɣəj^{C1}	ɣaj^{C1}	ɣaːj^{C1}	ɣaj^{B2}
88	*learn by heart*	làu	law^{A2}	law^{A2}	laːw^{A2}	naw^{A2}
89	*kowtow*	lạy	laj^{B2}	laj^{B2}	laːj^{B2}	naj^{B2}
90	*remuer, délayer, stir, mix*	quay	kʷaj^{A1}	kʷaj^{A1}	kʷaːj^{A1}	kʷaj^{A1}
91	*couper, enlever, châtrer, to cut off, pluck, castrate*	ngắt	ŋat^{D1}	ŋat^{D1}	ŋɨj^{B1}	ŋik^{D1}
92	*maize corn*	bắp	ɓap^{D1}	ɓap^{D1}	mɔn^{B2}	ɓaːp^{D1}
93	*bailer*	gàu	ɣaw^{A2}	xaw^{A1}	xɔj^{B1}	ɣaw^{A2}
94	*grosse mouche, bluebottle fly*	nhặng	ɲaŋ^{B2}	laŋ^{A2}	kiə^{B1}	ɲaŋ^{B2}
95	*cueillir to pick", bứt "cueillir, to pick", vắt "épiler, to pluck*	vặt	vat^{D2}	vat^{D2}	ɓɨt^{D1}	ɲo^{B2}
96	*riche, rich*	giàu	zaw^{A2}	zaw^{A2}	zaːw^{A2}	zaw^{A2}
97	*behind*	sau	saw^{A1}	saw^{A1}	saːw^{A1}	tʰaw^{A1}
98	*légumes, vegetables*	rau	zaw^{A1}	zaw^{A1}	zæw^{A1}	zaw^{A1}
99	*sève, sang, sap, blood*	máu	maw^{B1}	maw^{B1}	mæw^{B1}	maw^{B1}

	Gloss	*Standard orthography*	*Hà Nội*	*Cổ Định*	*Nghi Ân*	*Diêm Điền*
100	*six, six*	sáu	saw^{B1}	saw^{B1}	sæw^{B1}	tʰaw^{B1}
101	*entangling*	xoắn	sʷan^{B1}	sʷan^{B1}	sʷaːn^{B1}	sʷan^{B1}
102	*fish scales*	vẩy	vəj^{C1}	ɓan^{C1}	vaːj^{C1}	vaj^{B2}
103	*younger sibling*	em	ʔɛm^{A1}	ʔʲɛm^{A1}	ʔɛm^{A1}	ʔiəm^{A1}
104	*pinch*	véo	vɛw^{B1}	vɛw^{B1}	vəp^{D1}	ɓɛw^{B2}
105	*riz non glutineux, nonglutinous rice*	tẻ	tɛ^{C1}	tɛ^{C1}		tɛ^{B2}
106	*mouth corners*	mép	mɛp^{D1}	mɛp^{D1}	meŋ^{B1}	mɛp^{D1}
107	*mère > femelle, mother > female*	mẹ	mɛ^{B2}	mɛ^{B2}	mʲɛ^{B2}	ma^{B2}
108	*mentoring*	kèm	kɛm^{A2}	kɛm^{A2}	kɛm^{A2}	kem^{A2}
109	*racine, root*	rễ	ze^{C1}	zɛn^{C1}	zɛ^{C1}	zɛn^{C1}
110	*excrément, faeces*	ỉa	ʔiəᶜ¹	ʔiəᶜ¹	ʔɛ^{B1}	ʔiə^{B2}
111	*bouche, mouth*	miệng	miəŋ^{B2}	mom^{A2}	muəm^{A2}	mom^{A2}
112	*to glance*	liếc	liək^{D1}	liək^{D1}	liək^{D1}	niək^{D1}
113	*lécher, to lick*	liếm	liəm^{B1}	lim^{B1}	liəm^{B1}	niəm^{B1}
114	*sourd, deaf*	điếc	ɗiək^{D1}	ɗik^{D1}	ɗiək^{D1}	ɗiək^{D1}
115	*bouchée, morceau, mouthful, piece of,*	miếng	miəŋ^{B1}	miŋ^{B1}	meŋ^{B1}	miəŋ^{B1}
116	*fourmi, ant*	kiến	kiən^{B1}	kin^{B1}	kiən^{B1}	kiən^{B1}
117	*cerf, stag*	nai	naːj^{A1}	naːj^{A1}	nʷaːj^{A1}	naːj^{A1}
118	*fruit, fruit*	trái	tɕaːj^{B1}	tɕəj^{B1}	tɕəj^{B1}	taːj^{B1}
119	*that*	đấy	ɗəj^{B1}	te^{A1}	ɗɔ^{B1}	nəːj^{B1}
120	*son in law*	rể	zeᶜ¹	zeᶜ¹	ze^{B1}	ze^{B2}
121	*tranquility*	êm	ʔem^{A1}	ʔem^{A1}	ʔem^{A1}	ʔem^{A1}
122	*wound, ulcer; to swell*	phình	fiŋ^{A2}	feŋ^{A2}	feŋ^{A2}	fiŋ^{A2}
123	*fatigué, tired*	mệt	met^{D2}	ɲɔːk^{D2}	ɓɛw^{B2}	ɲɔk^{D2}
124	*erecting ears*	vểnh	veŋ^{C1}	veŋ^{C1}	veŋ^{C1}	veŋ^{B2}
125	*carambole (Averrhoa carambola), starfruit (Averrhoa carambola)*	khế	xe^{B1}	xe^{B1}	xe^{B1}	xe^{B1}
126	*advocate*	bênh	ɓeŋ^{A1}	ɓeŋ^{A1}	ɓeŋ^{A1}	ɓeŋ^{A1}
127	*moaning*	rên	zen^{A1}	zen^{A1}	zen^{A1}	zen^{A1}
128	*monter, to mount*	lên	len^{A1}	len^{A1}	len^{A1}	nen^{A1}
129	*réservoir, retenue d'eau, tank, water storage*	bể	ɓe^{C1}	ɓe^{C1}	ɓe^{C1}	ɓe^{C1}
130	*(riz) glutineux, glutinous (rice)*	nếp	nep^{D1}	nep^{D1}	nep^{D1}	nep^{D1}
131	*village, village*	quê	kʷe^{A1}	kʷe^{A1}	kʷe^{A1}	kʷe^{A1}
132	*rentrer, to return*	về	ve^{A2}	viən^{A2}	ve^{A2}	ve^{A2}
133	*curcuma, turmeric*	nghệ	ŋe^{B2}	ŋe^{B2}	ŋɛ^{B2}	ŋe^{B2}
134	*millet (setaria), millet (setaria)*	kê	ke^{A1}	ke^{A1}	ke^{A1}	kiən^{A1}

	Gloss	Standard orthography	Hà Nội	Cổ Định	Nghi Ân	Diêm Điền
135	*corps, body*	mình	miŋ^{A2}	meŋ^{A2}	miŋ^{A2}	miŋ^{A2}
136	*illness*	bệnh	ɓeŋ^{B2}	ɓɛŋ^{B2}	ɓeŋ^{B2}	ɗaw^{A1}
137	*féminin female (animal)*	cái	ka:j^{B1}	kəj^{B1}	kəj^{B1}	ka:j^{B1}
138	*urine, urine*	đái	ɗa:j^{B1}	ɗəj^{B1}	ɗəj^{B1}	ɗa:j^{B1}
139	*féminin female*	gái	ɣa:j^{B1}	kəj^{B1}	ɣəj^{B1}	ɣa:j^{B1}
140	*fruitful*	sai	sa:j^{A1}	səj^{A1}	səj^{A1}	səj^{A1}
141	*épine, thorn*	gai	ɣa:j^{A1}	kəj^{A1}	ɣəj^{A1}	ɣa:j^{A1}
142	*ci, ceci|this*	này	naj^{A2}	ni^{A1}	ni^{A1}	nəj^{A2}
143	*toi, tu|you (sing.)*	mày	maj^{A2}	mi^{A1}	mi^{A1}	məj^{A2}
144	*bras, main, arm, hand*	tay	taj^{A1}	taj^{A1}	ta:j^{A1}	taj^{A1}
145	*ivre, be drunk*	say	saj^{A1}	saj^{A1}	sa:j^{A1}	tʰaj^{A1}
146	*pilon, pestle*	chày	tɕaj^{A2}	tɕaj^{A2}	tɕa:j^{A2}	tɕaj^{A1}
147	*nageoire, fin*	vây	vəj^{A1}	vəj^{A1}	vəj^{A1}	vəj^{A1}
148	*pou de tête, head louse*	chấy	tɕəj^{B1}	tɕi^{B1}	tɕi^{B1}	tɕəj^{B1}
149	*bâton de marche, walking stick*	gậy	ɣəj^{B2}	ɣaj^{B2}	ɣaj^{B2}	ɣəj^{B2}
150	*importunate*	rầy	zəj^{A2}	zaj^{A2}	zaj^{A2}	
151	*se réveiller, se lever, to awaken, to rise*	dậy	zəj^{B2}	zaj^{B2}	za:j^{B2}	zəj^{B2}
152	*line, cord*	dây	zəj^{A1}	ɗəj^{A1}	tɕʷa:k^{D2}	zəj^{A1}
153	*prendre, to take*	lấy	ləj^{B1}	ləj^{B1}	ləj^{B1}	nəj^{B1}
154	*to surround*	vây	vəj^{A1}	vəj^{A1}	vəj^{A1}	vi^{B1}
155	*centipède, centipede*	rết	zet^{D1}	zik^{D1}	zit^{D1}	tik^{D1}
156	*mourir, to die*	chết	tɕet^{D1}	tɕet^{D1}	tɕet^{D1}	tɕet^{D1}
157	*to spread*	phết	fet^{D1}	fet^{D1}	kʷet^{D1}	
158	*traces (de pas), footprints*	vết	vet^{D1}	vet^{D1}	vet^{D1}	vit^{D1}
159	*cover blood*	rịt	zit^{D2}	ɓuək^{D2}	zit^{D2}	ɓik^{D2}
160	*horizontal pillars of house*	vì	vi^{A2}	vəj^{A2}	vəj^{A2}	va:j^{A2}
161	*holding back*	níu	niw^{B1}	niw^{B1}	ɲɔ:k^{D2}	niw^{B1}
162	*soeur aînée, elder sister*	chị	tɕi^{B2}	tɕəj^{B2}	tɕəj^{B2}	tɕi^{B2}
163	prostitute, vulgar	đĩ	ɗi^{c2}	ɗəj^{c1}	ɗəj^{B2}	ɗi^{B2}
164	*sorte de singe (kind of) monkey*	khỉ	xi^{c1}	xi^{c1}	xi^{B1}	xi^{B2}
165	*cadette (par alliance), younger (f.) in law*	dì	zi^{A2}	zəj^{A2}	zəj^{A2}	zi^{A2}
166	*kneeling*	quỳ	kʷi^{A2}	kʷəj^{A2}	kʷəj^{A2}	kʷi^{A2}
167	*dysentery*	lị	li^{B2}	kit^{D1}	ləj^{B2}	ni^{B2}
168	*oiseau, bird*	chim	tɕim^{A1}	tɕim^{A1}	tɕim^{A1}	ko^{A2}
	Gloss	**Standard**	**Hà Nội**	**Cổ Định**	**Nghi Ân**	**Diêm Điền**

		orthography				
169	*paupière, eyelid*	mí	mi^{B1}	mi^{B1}	mi^{B1}	mi^{B1}
170	*peu, few*	ít	ʔit^{D1}	ʔik^{D1}	ʔit^{D1}	ʔik^{D1}
171	*pliers*	kìm	kim^{A2}	kim^{A2}	kɛm^{A2}	kem^{A2}
172	*tongue twister*	lịu	liw^{B2}	liw^{B1}	liw^{B1}	niw^{B1}
173	*excréments, faeces*	cứt	kɨt^{D1}	kɨt^{D1}	kɨt^{D1}	kik^{D1}
174	*milan, kite*	diều	ziəw^{A2}	ɗiw^{A2}	ka:j^{B2}	ziəw^{A2}
175	*de côté, on the side of*	nghiêng	ŋiəŋ^{A1}	ŋiəŋ^{A1}	ŋiəŋ^{A1}	ŋiəŋ^{A1}
176	*advise*	khuyên	x^{w}iən^{A1}	x^{w}in^{A1}	x^{w}iən^{A1}	x^{w}iən^{A1}
177	*an area (of grass, hair)*	chỏm	tɕɔm^{C1}	tɕɔm^{C1}	tɕɔm^{B1}	tɕɔm^{B2}
178	*benching back*	khom	xɔm^{A1}	xuəm^{A1}	xɔm^{A1}	kɔŋ^{A1}
179	*make a fire*	nhóm	ɲɔm^{B1}	ɲuən^{B1}	ɲɛn^{B1}	ɲɛn^{A1}
180	*brûlure, burn*	bỏng	ɓɔŋ^{C1}	ɓuəŋ^{C1}	ɓaw^{B2}	ɓɔŋ^{B2}
181	*to collect, contribute to*	gom	ɣɔm^{A1}	ɣuəm^{A1}	kɔt^{D1}	ɣɔp^{D1}
182	*asticot de mouche, maggot of fly*	dòi	zɔj^{A2}	ʈuɔj^{A1}	ziəw^{A2}	zɔj^{A2}
183	*tailler, ciseler, to carve, chisel*	gọt	ɣɔt^{D2}	xɔt^{D1}	ɗə:n^{B1}	ɣɔt^{D2}
184	*big sieve*	nong	nɔŋ^{A1}	niə^{A1}	no:ŋ^{B1}	nɔŋ^{A1}
185	*young rice flower*	đòng	ɗɔŋ^{A2}	ɗaŋ^{A2}	ɗɔŋ^{A2}	ɗɔŋ^{A2}
186	*he, it*	nó	nɔ^{B1}	hən^{B1}	hən^{B1}	nɔ^{B1}
187	*corncob*	lõi	lɔj^{C2}	luəj^{C1}	lɔj^{C2}	koj^{A2}
188	*too hasty*	sòn	sɔn^{A2}	sɔn^{A2}	sɔn^{A2}	
189	*tatouer, piquer de petits trous, tattoo, poke small holes*	chọc	tɕɔk^{D2}	tɕɔ:k^{D2}	tɕak^{D2}	tɕɔk^{D2}
190	*to light a fire*	nhóm	ɲɔm^{B1}	ɲuən^{B1}	ɲɔm^{B1}	ɲɛn^{A1}
191	*braised fish*	om	ʔɔm^{A1}	ʔuəm^{A1}	ʔɔm^{A1}	ʔum^{A1}
192	*planting*	trồng	tɕoŋ^{A2}	tɕɔŋ^{A2}	tɛ^{B1}	toŋ^{A1}
193	*riz paddy, paddy rice*	lúa	luə^{B1}	lɔ^{B2}	lɔ^{B1}	nuə^{B1}
194	*sel, salt*	muối	muəj^{B1}	m^{w}əj^{B1}	məj^{B1}	muəj^{B1}
195	*avaler, to swallow*	nuốt	nuət^{D1}	n^{w}ət^{D1}	nɔt^{D1}	nuət^{D1}
196	*moustique, mouche, mosquito, fly*	muỗi	muəj^{C2}	mɔn^{C1}	məj^{B2}	muəj^{B2}
197	*mouche, fly*	ruồi	zuəj^{A2}	zɔj^{A2}	zɔj^{A2}	zuəj^{A2}
198	*intestins, intestines*	ruột	zuət^{D2}	zɔt^{D2}	zɔt^{D2}	zuət^{D2}
199	*tortue, tortoise*	rùa	zuə^{A2}	zuə^{A2}	zuə^{A2}	zuə^{A2}
200	*to go under*	luồn	luən^{A2}	lɔn^{A2}	luən^{A2}	nuən^{A2}
201	*bouillir (int.), to boil (int.)*	luộc	luək^{D2}	luək^{D2}	lɔk^{D2}	nuək^{D2}
202	*queue, tail*	đuôi	ɗuəj^{A1}	ɗuj^{A1}	ɗuəj^{A1}	ɗuəj^{A1}
	Gloss	***Standard***	***Hà Nội***	***Cổ Định***	***Nghi Ân***	***Diêm Điền***

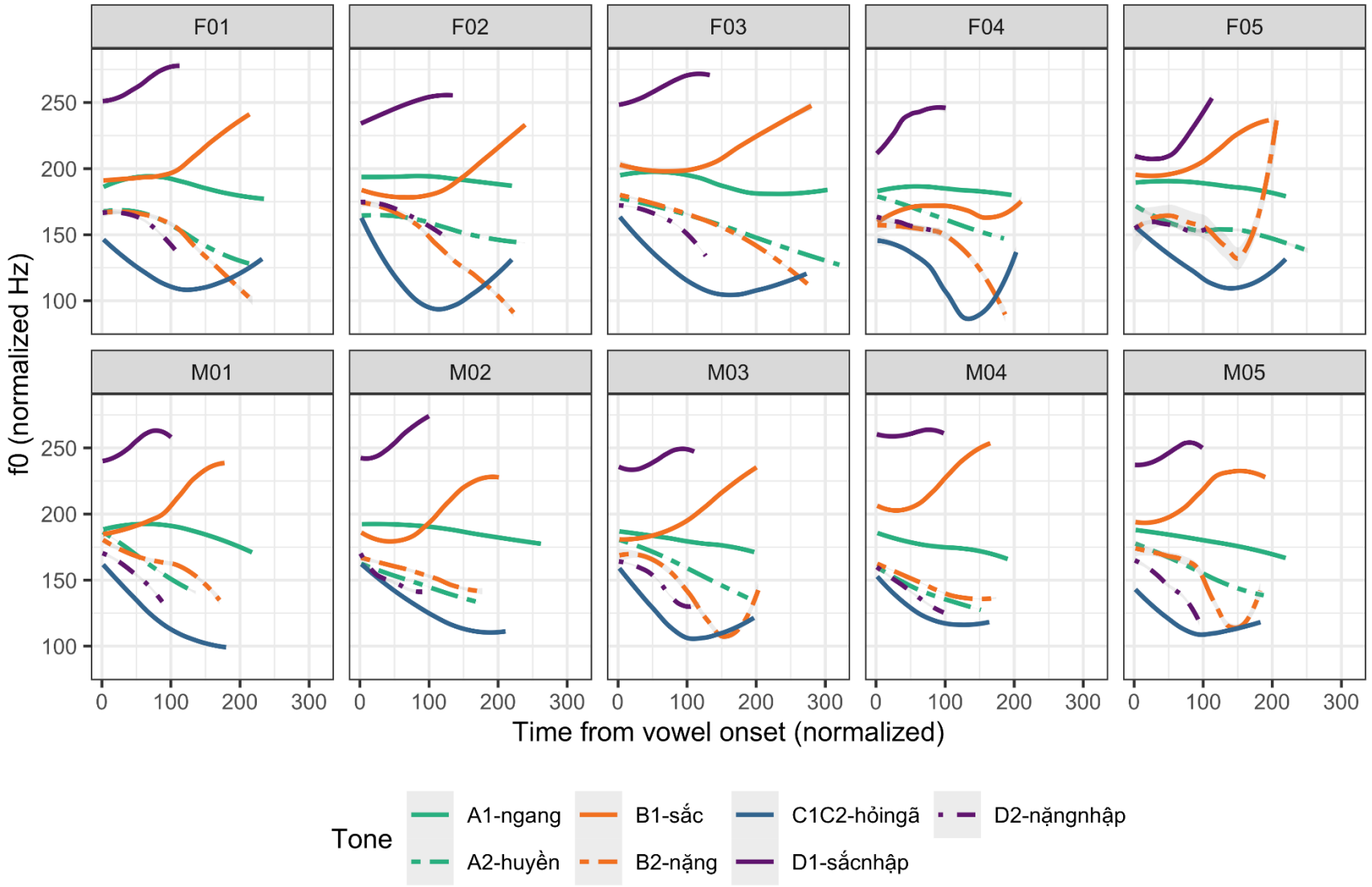
		orthography				
203	*grumpy*	cộc	kok^{D2}	kɔk^{D2}	kɔk^{D2}	kuk^{D2}
204	*to perch*	đậu	ɗəw^{B2}	ɗaw^{B2}	ɗɔ^{B2}	ɗəw^{B2}
205	*entrer, to enter*	vào	va:w^{A2}	vo^{A1}	vo^{A1}	vo^{A1}
206	*riz décortiqué, husked rice*	gạo	ɣa:w^{B2}	kəw^{B1}	ɣɤw^{B2}	ɣa:w^{B2}
207	*where*	đâu	ɗəw^{A1}	mo^{A1}	mo^{A1}	ɗəw^{A1}
208	*haricot, beans*	đậu	ɗəw^{B2}	ɗo^{C2}	ɗɔ^{B2}	ɗo^{B2}
209	*protruding teeth*	vẩu	vəw^{c1}	ho^{A1}	vəw^{c1}	ho^{A1}
210	*cuire (à l'eau), cuisiner, to boil water, to cook*	nấu	nəw^{B1}	nəw^{B1}	nəw^{B1}	nəw^{B1}
211	*luciole, luciola|firefly*	đóm	ɗɔm^{B1}	ɗom^{B1}	ɗɔm^{B1}	ɗom^{B1}
212	*curved up*	vỏng	vɔŋ^{C1}	voŋ^{C1}	vaŋ^{C1}	
213	*spit*	nhổ	ɲo^{c1}	tɕo^{c1}	ɲo^{B1}	ɲo^{B2}
214	*ignorant*	dốt	zot^{D1}	zot^{D1}	zot^{D1}	zot^{D1}
215	*embryo*	phôi	foj^{A1}	foj^{A1}	foj^{A1}	
216	*capital*	vốn	von^{B1}	von^{B1}	von^{B1}	von^{B1}
217	*hurry, hasten*	vội	voj^{B2}	voj^{B2}	vɔj^{B2}	ɣəp^{D1}
218	*père, father*	bố	ɓo^{B1}	ɓo^{B1}	niw^{B1}	tɕa^{A1}
219	*to bloom*	rộ	zo^{B2}	zo^{B2}	zɔ^{B2}	zo^{B2}
220	*termite, termite*	mối	moj^{B1}	mon^{B1}	moj^{B1}	moj^{B1}
221	*un, one*	một	mot^{D2}	mot^{D2}	mɔt^{D2}	mot^{D2}
222	*upside down*	lộn	lon^{B2}	lon^{B2}	lɔn^{B2}	non^{B2}
223	*entre-noeud, phalange, inter-node, phalanx*	đốt	ɗot^{D1}	ʔuəŋ^{B1}	laŋ^{B1}	ɗot^{D1}
224	*first ten days*	mùng	muŋ^{A2}	moŋ^{A2}	moŋ^{A2}	moŋ^{A2}
225	*clumsy*	vụng	vuŋ^{B2}	voŋ^{B2}	voŋ^{B2}	vuŋ^{B2}
226	*chance, oppurtunity*	đợt	ɗə:t^{D2}	ɗə:t^{D2}	ɗa:t^{D2}	ɗə:t^{D2}
227	*fish trap*	lờ	lə^{A2}	lə^{A2}	zət^{D2}	nɨ^{A2}
228	recover	đỡ	ɗə^{C2}	ɗə^{C2}	fɔŋ^{B1}	ɗə^{B2}
229	*untangling*	gỡ	ɣə^{C2}	xə^{C2}	ɣɔt^{D2}	xə^{B2}
230	*épouse aîné de la mère, moth's elder broth's wife*	mợ	mə^{B2}	mə^{B2}	la^{A2}	mə^{B2}
231	*belch*	ợ	ʔə^{B2}	ʔə^{B2}	ʔa^{B2}	ʔə^{B2}
232	*pampering*	cưng	kɨŋ^{A1}	kɨŋ^{A1}	kɨŋ^{A1}	kɨŋ^{A1}
233	*hiding*	nấp	nəp^{D1}	nəp^{D1}	nəp^{D1}	nup^{D1}
234	*to receive*	nhận	ɲən^{B2}	ɲən^{B2}	ɲan^{B2}	ɲən^{B2}
235	*flies gathering on smt*	bâu	ɓəw^{A1}	ɓu^{A1}	ɓu^{A1}	ɓu^{A1}
236	*Cyperus rotundus*	gấu	ɣəw^{B1}	ɣəw^{B1}	ku^{B1}	ɣəw^{B1}

	Gloss	Standard orthography	Hà Nội	Cổ Định	Nghi Ân	Diêm Điền
237	*daughter in law*	dâu	zəw^{A1}	zu^{A1}	zu^{A1}	zəw^{A1}
238	*hide*	giấu	zəw^{B1}	zəw^{B1}	tʰu^{A1}	tʰu^{A1}
239	*brown color*	nâu	nəw^{A1}	nu^{A1}	nu^{A1}	nəw^{A1}
240	*profond, deep*	sâu	səw^{A1}	su^{A1}	su^{A1}	tʰu^{A1}
241	*buffle, buffalo*	trâu	tɕəw^{A1}	tɕu^{A1}	tɕu^{A1}	təw^{A1}
242	*balle de riz, rice husk*	trấu	tɕəw^{B1}	tɕu^{B1}	tɕu^{B1}	təw^{B1}
243	*gourde calebasse (Lagenaria), Indian gourd (Lagenaria)*	bầu	ɓəw^{A2}	ɓəw^{A2}	ɓu^{A2}	ɓəw^{A2}
244	*cadet de la mère/épouse, younger broth's moth/wife*	cậu	kəw^{B2}	kəw^{B2}	kəw^{B2}	ku^{B2}
245	*aréquier, areca, arecanut, areca*	trầu	tɕəw^{A2}	tɕəw^{A2}	tɕu^{A2}	təw^{A2}
246	*ours, bear*	gấu	ɣəw^{B1}	ɣəw^{B1}	ɣəw^{B1}	ɣəw^{B1}
247	*mûre, blackberry*	dâu	zəw^{A1}	ɗəw^{A1}	zəw^{A1}	zəw^{A1}
248	*cheveux, poil, plume, head-hair, hair, feather*	tóc	tɔk^{D1}	tak^{D1}	tak^{D1}	tɔk^{D1}
249	*genou, knee*	gối	ɣoj^{B1}	kun^{B1}	kuj^{B1}	ɣoj^{B1}
250	*broom*	chổi	tɕoj^{c1}	tɕun^{c1}	tɕuj^{B1}	tɕoj^{B2}
251	*navel*	rốn	zon^{B1}	zun^{B1}	zun^{B1}	zun^{B1}
252	*kiss*	hôn	hon^{A1}	hun^{A1}	hun^{A1}	hon^{A1}
253	*intelligent*	khôn	xon^{A1}	xun^{A1}	xun^{A1}	xun^{A1}
254	*lèvres, lips*	môi	moj^{A1}	muj^{A1}	muj^{A1}	moj^{A1}
255	*sombre, soir, dark, evening*	tối	toj^{B1}	tun^{B1}	tuj^{B1}	tuj^{B1}
256	*making lime*	tôi	toj^{A1}	to^{A1}	su^{B1}	tʰu^{B1}
257	*pourri, rotten*	thối	tʰoj^{B1}	tʰun^{B1}	tʰuj^{B1}	tʰuj^{B1}
258	*to touch*	động	ɗoŋ^{B2}	ɗɔŋ^{B2}	ɗɔŋ^{B2}	ɗuŋ^{B2}
259	*chaux, lime*	vôi	voj^{A1}	voj^{A1}	voj^{A1}	voj^{A1}
260	*souffler, to blow*	thổi	tʰoj^{c1}	tʰun^{c1}	tʰoj^{c1}	tʰoj^{B2}
261	*allumer le feu, to light a fire*	đốt	ɗot^{D1}	ɗot^{D1}	ɗot^{D1}	ɗot^{D1}
262	*chauffer cuire, to heat, cook", (nóng "chaud, hot)*	tôi	toj^{A1}	toj^{A1}	tuj^{A1}	tuj^{A1}
263	*tangling*	rối	zoj^{B1}	zoj^{B1}	zuj^{B1}	ɓuj^{B1}
264	*white skin of fruits*	cùi	kuj^{A2}	kuj^{A2}	koj^{A2}	kuj^{A2}
265	*porter à la hotte, to carry on the back (in a basket)*	gùi	ɣuj^{A2}	ɣuj^{A2}	ɣoj^{A2}	ɣuj^{A2}
266	*tubercule, tuber*	củ	ku^{C1}	ku^{C1}	ko^{B1}	ku^{B2}
267	*old*	cũ	ku^{C2}	kəw^{C1}	kɔ^{B2}	ku^{B2}
268	*grandparents*	cụ	ku^{B2}	ko^{B1}	ko^{B1}	ku^{B2}
269	***Basella alba***	mùng	muŋ^{A2}	moŋ^{A2}	moŋ^{A2}	moŋ^{A2}
	Gloss	**Standard**	**Hà Nội**	**Cổ Định**	**Nghi Ân**	**Diêm Điền**

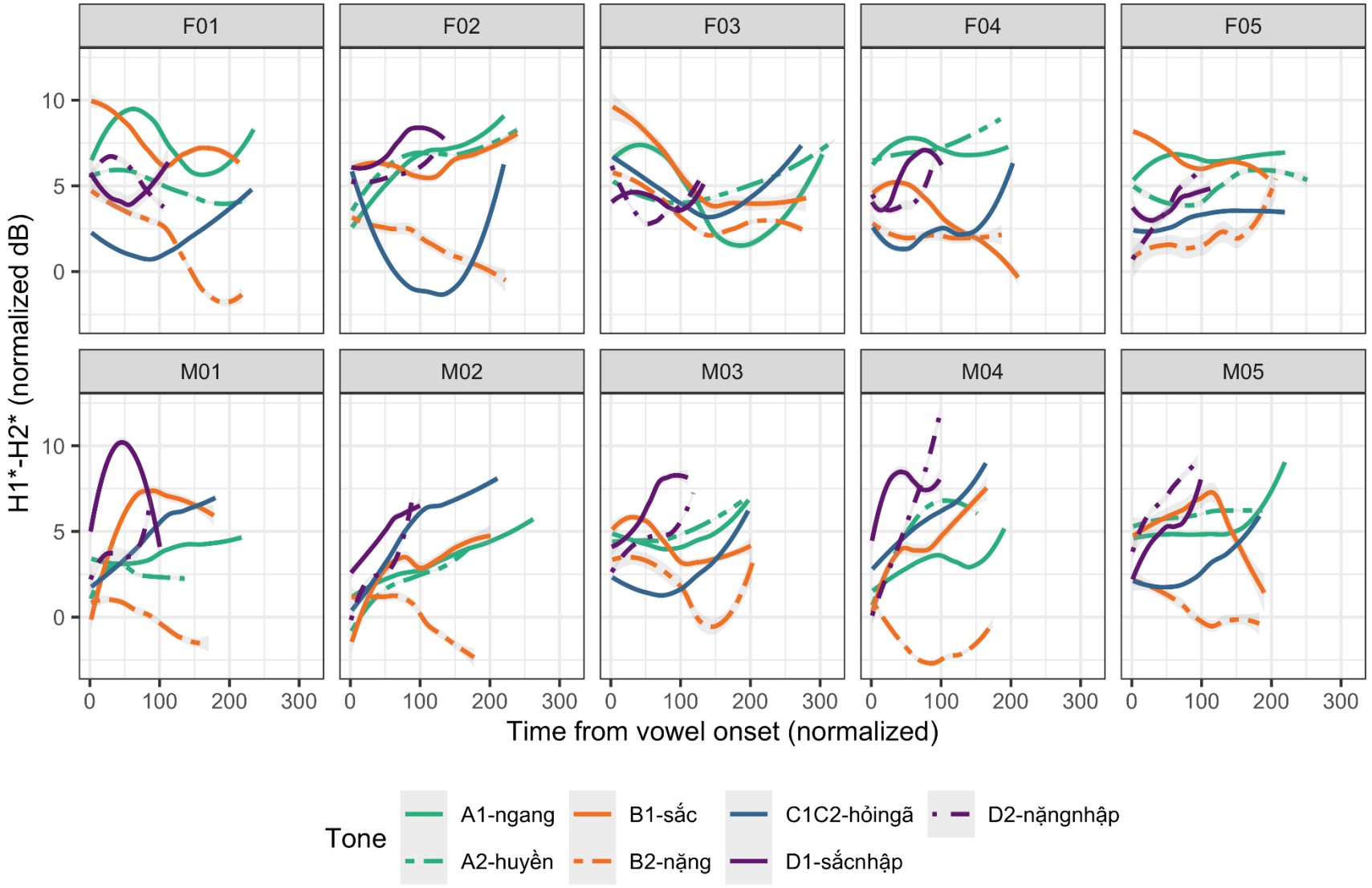
		orthography				
270	*chignon, bun*	búi	ɓuj^{B1}	ɓun^{B1}	ɓoj^{B1}	ɓuj^{B1}
271	*frame*	khung	xuŋ^{A1}	xuŋ^{A1}	xuŋ^{A1}	xuŋ^{A1}
272	*with holes*	thủng	tʰuŋ^{C1}	tʰuŋ^{C1}	tʰuŋ^{B1}	toːŋ^{C1}
273	*crumbs*	mủn	mun^{C1}	mun^{C1}	ɗa^{B2}	naːt^{D1}
274	*sève sap*	mủ	mu^{C1}	mu^{C1}	moj^{B1}	mu^{B2}
275	*to punch*	thụi	tʰuj^{B2}	tʰuj^{B2}	tʰoj^{B2}	
276	*Sindora tonkinensis (mahogany)*	gụ	ɣu^{B2}	ɣəw^{B2}	ɣəw^{B2}	ɣu^{B2}
277	*hit with stick*	quật	kʷət^{D2}	kʷɨt^{D1}	kʷɨt^{D1}	kʷik^{D1}
278	*près, near*	gần	ɣən^{A2}	ɣən^{A2}	ɣin^{A1}	ɣən^{A2}
279	*undulating*	nhấp	ɲəp^{D1}	ɲɨp^{D1}	ɲəp^{D1}	ɲəp^{D1}
280	*rouler (cigarette), enrouler, to roll (cigarette), to wrap*	vấn	vən^{B1}	vən^{B1}	kʷin^{B1}	kuən^{B1}
281	*jambe, pied, leg, foot*	chân	tɕən^{A1}	tɕin^{A1}	tɕin^{A1}	tɕən^{A1}
282	*tonnerre, thunder*	sấm	səm^{B1}	səm^{B1}	səm^{B1}	səm^{B1}
283	*jeter, to throw*	vất	vət^{D1}	vɨt^{D1}	kʷæŋ^{A1}	kʷaŋ^{A1}
284	*level*	mức	mɨk^{D1}	mək^{D2}	mɨk^{D1}	mɨk^{D1}
285	*horny*	nứng	niŋ^{B1}	niŋ^{B1}	niŋ^{B1}	niŋ^{B1}
286	*erection*	cửng	kɨŋ^{C1}	kɨŋ^{B1}	kɨŋ^{B1}	kɨŋ^{B1}
287	*sentir flairer, feel, smell*	ngửi	ŋɨj^{C1}	ŋɨj^{C1}	vʷaːŋ^{A2}	ŋɨj^{B2}
288	*dur, hard*	cứng	kɨŋ^{B1}	kɨŋ^{B1}	kɨŋ^{B1}	kɨŋ^{B1}
289	*fort, strong*	sức	sɨk^{D1}	sɨk^{D1}	sɨk^{D1}	tʰɨk^{D1}
290	*confier, envoyer, to entrust, send*	gửi	ɣɨj^{C1}	ɣɨj^{C1}	ɣɨj^{B1}	ɣəːj^{B2}
291	*cueillir to pick", bứt "cueillir, to pick", vắt "épiler, to pluck*	bứt	ɓɨt^{D1}	ɓɨt^{D1}	ɓɨt^{D1}	ɓik^{D1}
292	*broken (wire)*	đứt	ɗɨt^{D1}	ɗət^{D1}	ɗɨt^{D1}	ɗik^{D1}
293	*suc, résine, drogue, sap, resin, drug*	nhựa	ɲiə^{B2}	ɲiə^{B2}	ɲiə^{B2}	ziŋ^{B1}
294	*lay back on*	tựa	tiə^{B2}	ziə^{B2}	tiə^{B2}	ziə^{B2}
295	quick cut by knives	cứa	kiə^{B1}	kiə^{B1}	kuəŋ^{B1}	kiə^{B1}
296	to give	đưa	ɗiə^{A1}	ɗiə^{A1}	ɗiə^{A1}	ɗiə^{A1}
297	*bobbin*	suốt	suət^{D1}	sut^{D1}	suət^{D1}	
298	*rouler (cigarette), enrouler, to roll (cigarette), to wrap*	cuốn	kuən^{B1}	kun^{B1}	kuən^{B1}	kuən^{B1}
299	*boire, to drink*	uống	ʔuəŋ^{B1}	ʔuŋ^{B1}	ʔuəŋ^{B1}	ʔuəŋ^{B1}
300	*rizière humide, wet rice*	ruộng	zuəŋ^{B2}	zuəŋ^{B2}	zʷaŋ^{B2}	zuəŋ^{B2}
301	*liseron d'eau (Ipomea x), water spinach (Ipomoea x)*	muống	muəŋ^{B1}	muŋ^{B1}	muəŋ^{B1}	muəŋ^{B1}
302	*vouloir, désirer, to wish, desire*	muốn	muən^{B1}	mun^{B1}	muən^{B1}	ʔiŋ^{A1}
303	*animal quadrupède quadruped*	muông	muəŋ^{A1}	muəŋ^{A1}	muəŋ^{A1}	muəŋ^{A1}
	Gloss	***Standard***	***Hà Nội***	***Cổ Định***	***Nghi Ân***	***Diêm Điền***

		orthography				
304	*veggies bed*	luống	luəŋ^{B1}	luŋ^{B1}	vʷak^{D2}	voŋ^{A2}
305	*rivière, ruisseau, river, brook*	suối	suəj^{B1}	suj^{B1}	suəj^{B1}	xɛ^{A1}
306	*descendre, to go down*	xuống	suəŋ^{B1}	suəŋ^{B1}	suəŋ^{B1}	suəŋ^{B1}
307	*pétiole, petiole*	cuống	kuəŋ^{B1}	kuəŋ^{B1}		kuəŋ^{B1}
308	*au-dessous, under*	dưới	ziəj^{B1}	ɗɨn^{B1}	tɕɔj^{A1}	ziəj^{B1}
309	*pamplemousse, pomelo*	bưởi	ɓiəj^{C1}	ɓɨnᶜ¹	ɓiəj^{B1}	ɓiəj^{B2}
310	*not yet*	chưa	tɕiə^{A1}	tɕiə^{A1}	tɕiə^{A1}	tɕiə^{A1}
311	*front, devant, forehead, before*	trước	tɕiək^{D1}	tɕik^{D1}	tɕiək^{D1}	tiək^{D1}
312	*le sang va couler blood flowing (Génibrel)*	rướm	ziəm^{B1}	zəːm^{B1}	zəːm^{B1}	zəːm^{B1}
313	*to cscold*	chửi	tɕij^{C1}	ɓəːj^{B1}	tɕiəj^{B1}	tɕiəj^{B2}

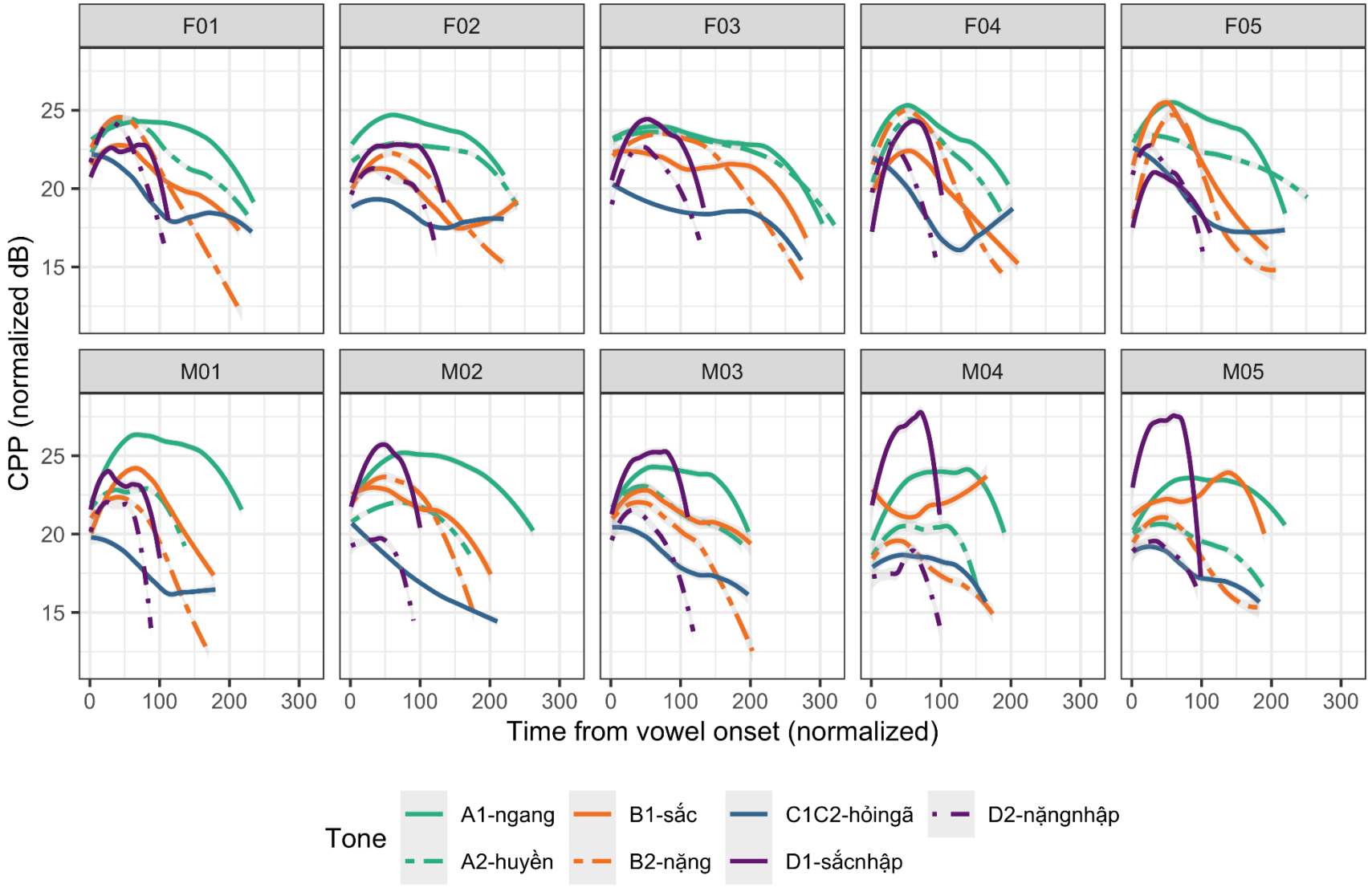
Appendix 6-2. Normalized f0 of individual tone systems in the Cổ Định dialect.



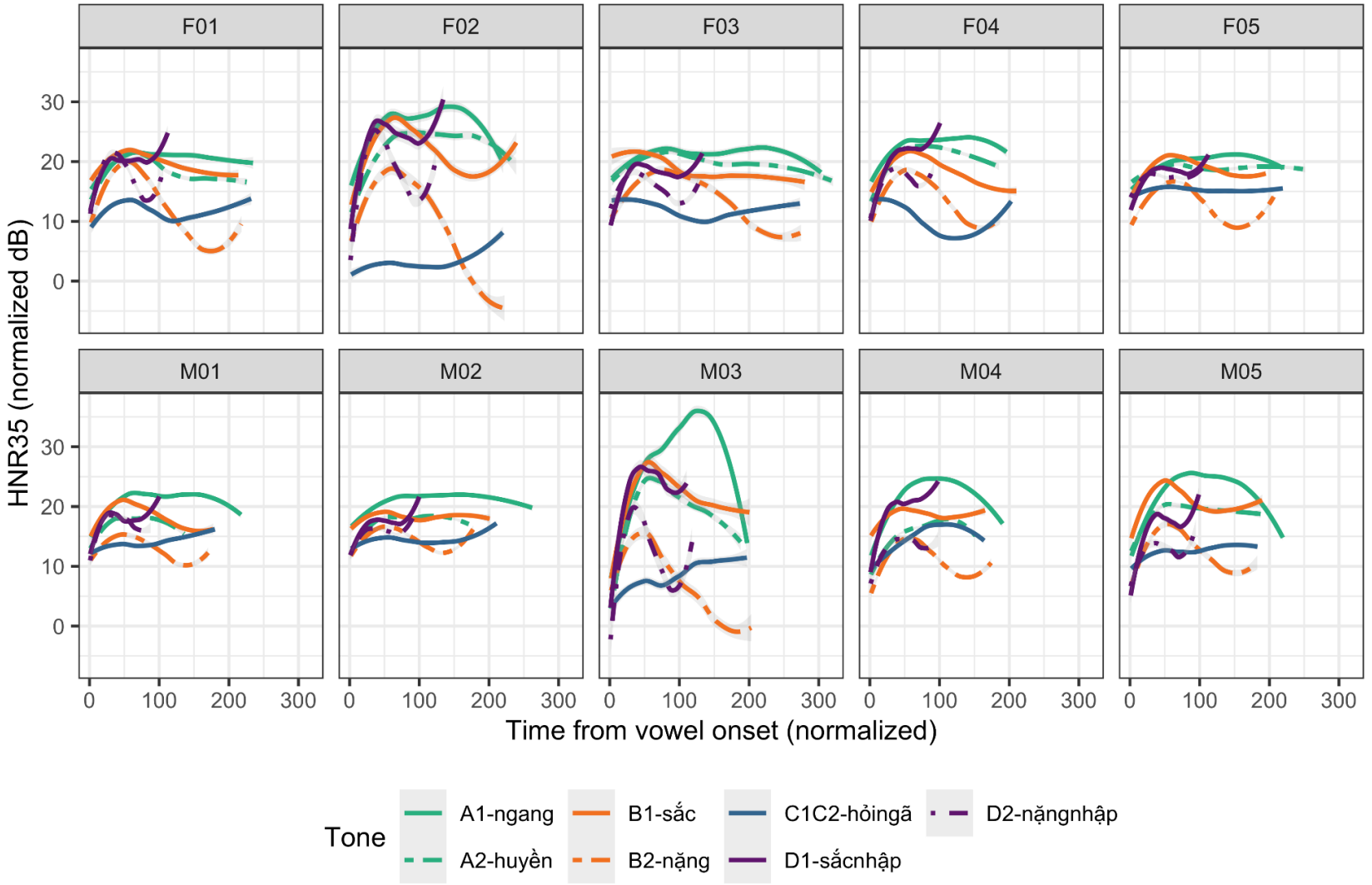
Appendix 6-3. Normalized H1*-H2* of individual tone systems in the Cổ Định dialect.



Appendix 6-4. Normalized CPP of individual tone systems in the Cổ Định dialect.



Appendix 6-5. Normalized HNR35 of individual tone systems in the Cổ Định dialect.

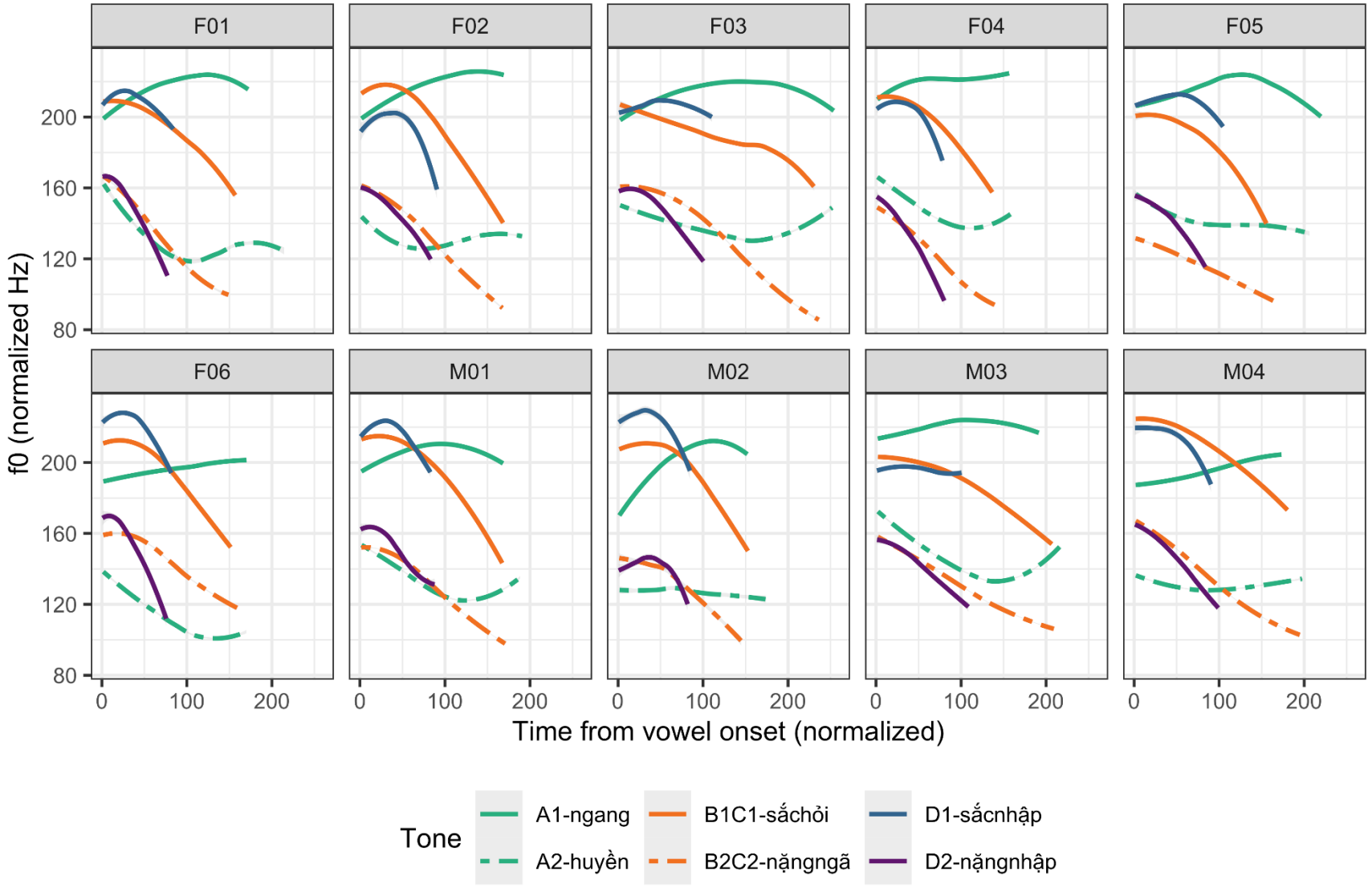


Appendix 6-6. Results of the linear mixed model fitted to the tone duration data of the Cổ Định dialect. Model*: Duration ~Tone*Vowel + (1|Subject) + (1|Word).*

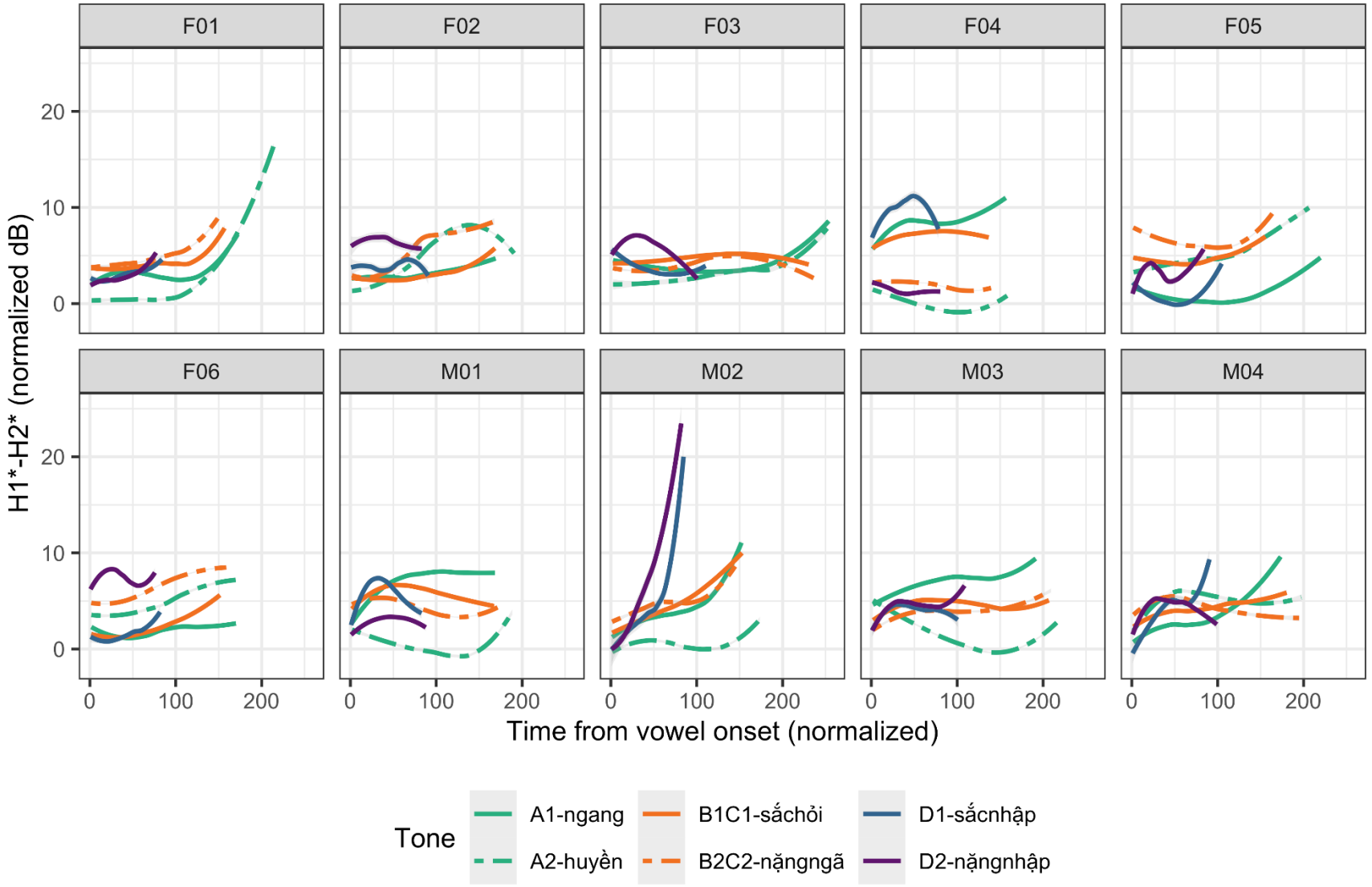
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	208.22	12.32	16.15	16.90	0.00***
ToneA2-huyền	-39.48	11.42	1067.26	-3.46	0.00***
ToneB1-sắc	20.92	9.98	1067.12	2.10	0.04*
ToneB2-nặng	-2.02	9.87	1067.15	-0.20	0.84
ToneC1C2-hỏngã	14.12	9.46	98.03	1.49	0.14
ToneD1-sắcnhập	-134.48	11.21	3.04	-11.99	0.00**
ToneD2-nặngnhập	-138.80	11.18	3.00	-12.41	0.00**
Vowelu:	19.96	11.52	3.39	1.73	0.17
Vowelɛ:	31.99	11.57	3.44	2.77	0.06
Vowela:	27.17	11.74	3.64	2.31	0.09
ToneA2-huyền:Vowelu:	-13.07	14.28	1067.18	-0.91	0.36
ToneB1-sắc:Vowelu:	-95.65	12.77	1067.08	-7.49	0.00***
ToneB2-nặng:Vowelu:	-67.90	12.58	1067.10	-5.40	0.00***
ToneC1C2-hỏngã:Vowelu:	-7.80	12.97	3.25	-0.60	0.59
ToneD1-sắcnhập:Vowelu:	11.11	14.72	1.91	0.75	0.53
ToneD2-nặngnhập:Vowelu:	22.62	14.70	1.90	1.54	0.27
ToneA2-huyền:Vowelɛ:	0.17	14.14	1067.16	0.01	0.99
ToneB1-sắc:Vowelɛ:	-27.51	12.70	1067.06	-2.17	0.03*
ToneB2-nặng:Vowelɛ:	-27.30	12.62	1067.09	-2.16	0.03*
ToneC1C2-hỏngã:Vowelɛ:	-62.54	11.80	212.04	-5.30	0.00***
ToneD1-sắcnhập:Vowelɛ:	9.34	14.78	1.94	0.63	0.59
ToneD2-nặngnhập:Vowelɛ:	-4.06	14.73	1.92	-0.28	0.81
ToneA2-huyền:Vowela:	44.37	14.33	1067.21	3.10	0.00**
ToneB2-nặng:Vowela:	-4.32	12.77	1067.08	-0.34	0.74
ToneC1C2-hỏngã:Vowela:	-64.52	11.92	218.43	-5.41	0.00***
ToneD1-sắcnhập:Vowela:	44.81	14.89	2.00	3.01	0.09
ToneD2-nặngnhập:Vowela:	41.91	14.89	2.00	2.81	0.11

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

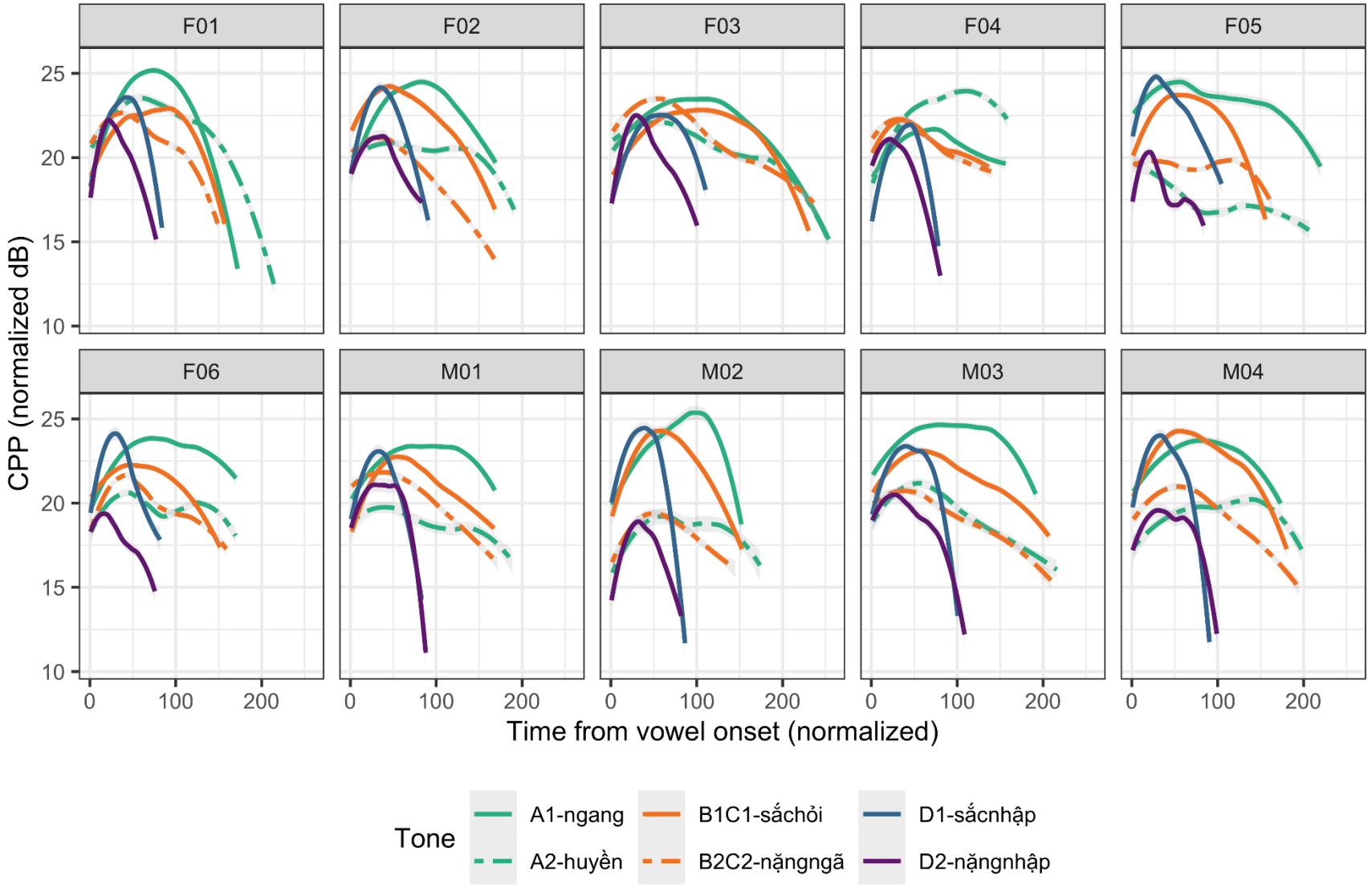
Appendix 6-7. Normalized f0 of individual tone systems in the Nghi Ân dialect.



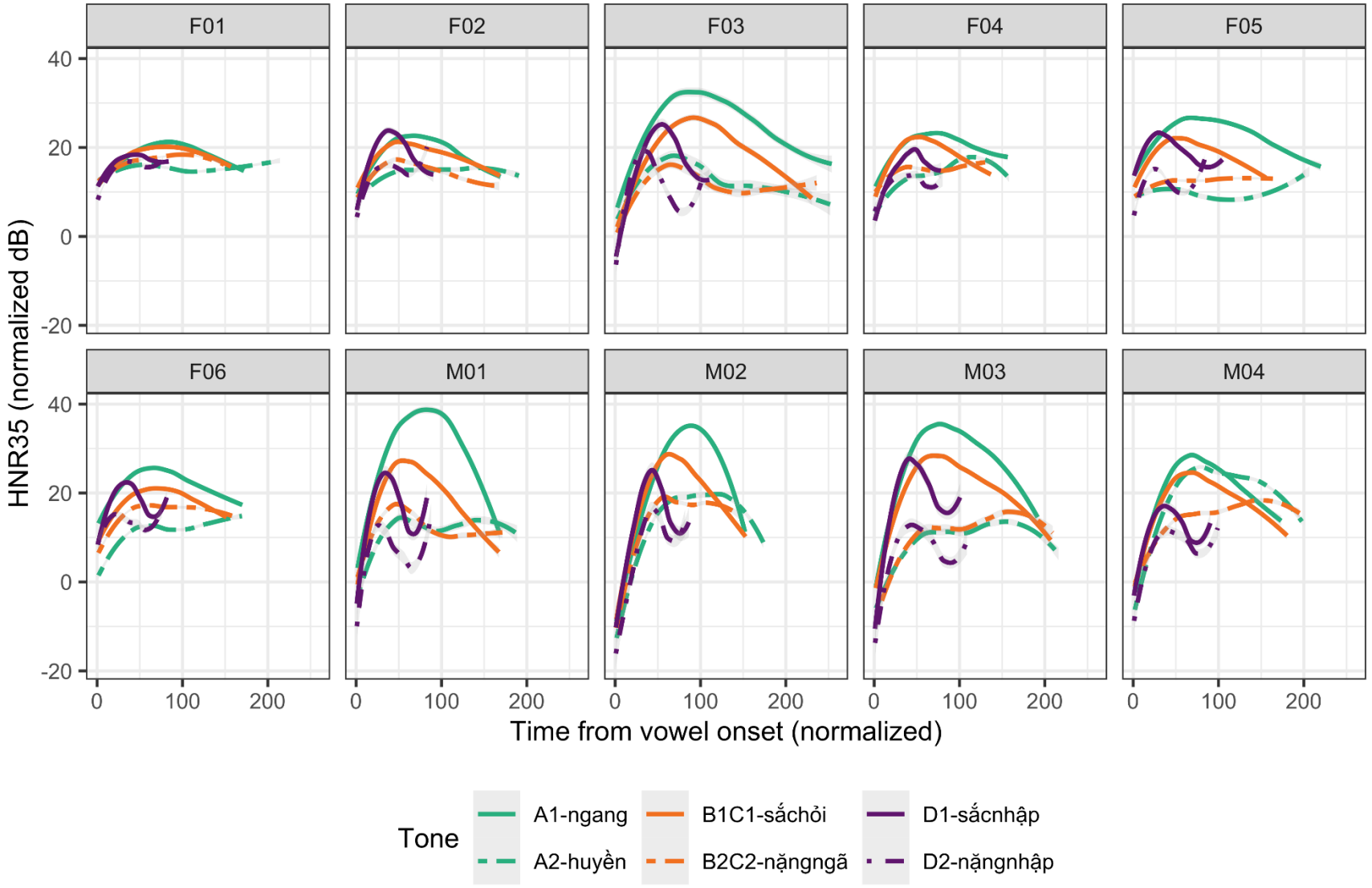
Appendix 6-8. Normalized H1*-H2* of individual tone systems in the Nghi Ân dialect.


F01
F02
F03
F04
F05
F06
M01
M02
M03
M04
H1*-H2* (normalized dB)
20
10
0
0
100
200
Time from vowel onset (normalized)
Tone
A1-ngang
A2-huyền
B1C1-sắchỏi
B2C2-nặngngã
D1-sắcnhập
D2-nặngnhập

Appendix 6-9. Normalized CPP of individual tone systems in the Nghi Ân dialect.



Appendix 6-10. Normalized HNR35 of individual tone systems in the Nghi Ân dialect.

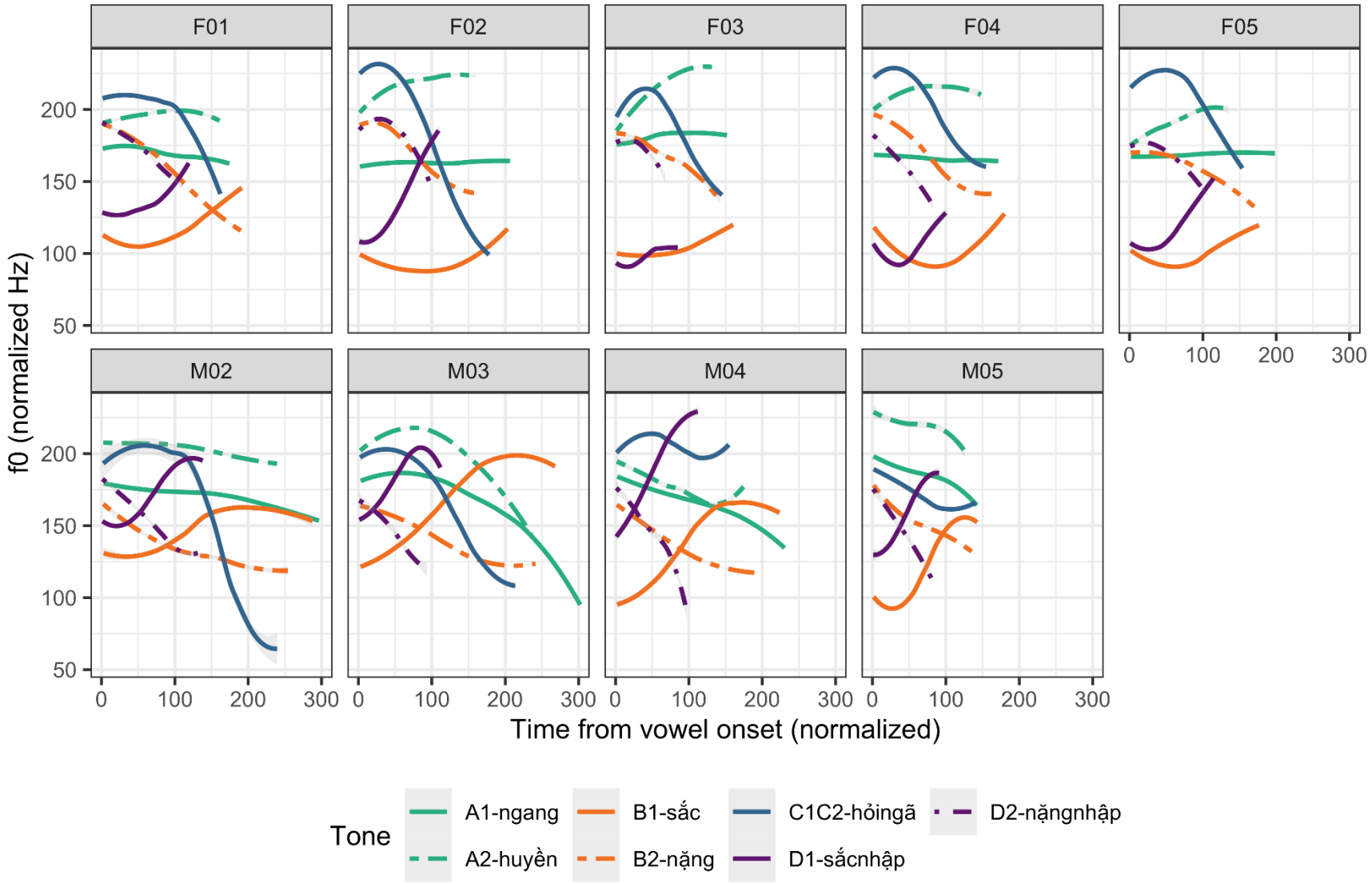


Appendix 6-11. Results of the linear mixed model fitted to the tone duration data of the Nghi Ân dialect. Model*: Duration ~Tone*Vowel + (1|Subject) + (1|Word).*

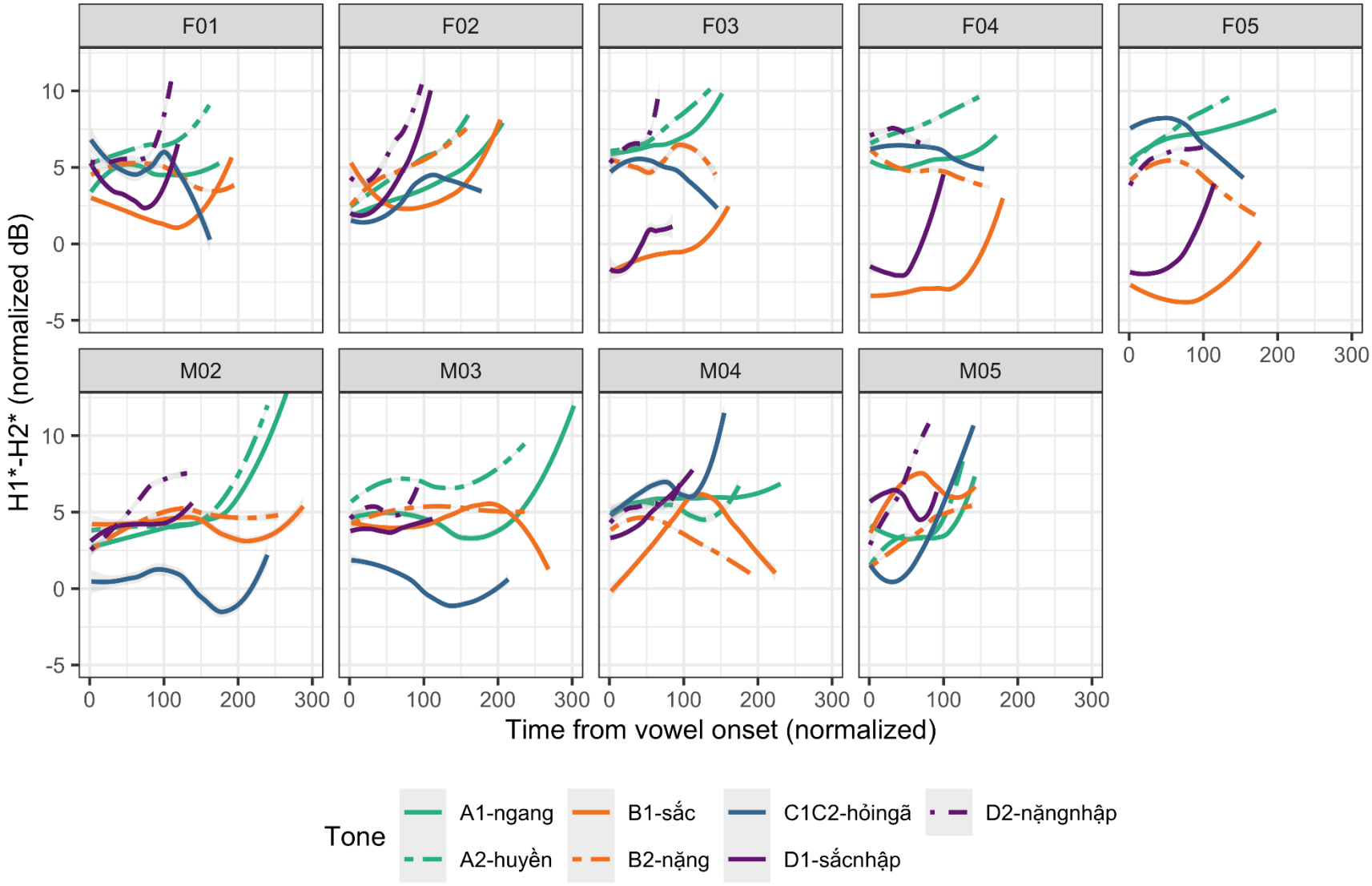
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	157.24	29.57	2.46	5.32	0.02*
ToneA2-huyền	15.58	7.57	1078.09	2.06	0.04*
ToneB1C1-sắchỏi	21.64	6.73	1078.08	3.21	0.00**
ToneB2C2-nặngngã	24.63	7.70	1077.89	3.20	0.00**
ToneD1-sắcnhập	-76.96	49.13	2.08	-1.57	0.25
ToneD2-nặngnhập	-84.97	49.17	2.09	-1.73	0.22
Vowelu:	56.54	40.48	2.16	1.40	0.29
Vowelɛ:	36.23	49.23	2.10	0.74	0.54
Vowela:	49.56	49.21	2.10	1.01	0.42
ToneA2-huyền:Vowelu:	-8.68	10.86	1078.16	-0.80	0.42
ToneB1C1-sắchỏi:Vowelu:	-64.60	9.22	1079.15	-7.01	0.00***
ToneB2C2-nặngngã:Vowelu:	-65.45	10.20	1079.52	-6.41	0.00***
ToneD1-sắcnhập:Vowelu:	-48.52	69.37	2.07	-0.70	0.55
ToneD2-nặngnhập:Vowelu:	-30.68	69.39	2.07	-0.44	0.70
ToneA2-huyền:Vowelɛ:	20.09	10.56	1078.06	1.90	0.06
ToneB1C1-sắchỏi:Vowelɛ:	-40.83	9.56	1078.10	-4.27	0.00***
ToneB2C2-nặngngã:Vowelɛ:	-63.75	10.15	1079.96	-6.28	0.00***
ToneD1-sắcnhập:Vowelɛ:	-24.58	74.82	2.06	-0.33	0.77
ToneD2-nặngnhập:Vowelɛ:	-32.67	74.84	2.06	-0.44	0.70
ToneA2-huyền:Vowela:	-26.44	10.58	1078.05	-2.50	0.01*
ToneB1C1-sắchỏi:Vowela:	-70.14	9.39	1078.06	-7.47	0.00***
ToneB2C2-nặngngã:Vowela:	-51.82	10.10	1079.97	-5.13	0.00***
ToneD1-sắcnhập:Vowela:	-26.06	74.80	2.05	-0.35	0.76
ToneD2-nặngnhập:Vowela:	-18.85	74.83	2.06	-0.25	0.82

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

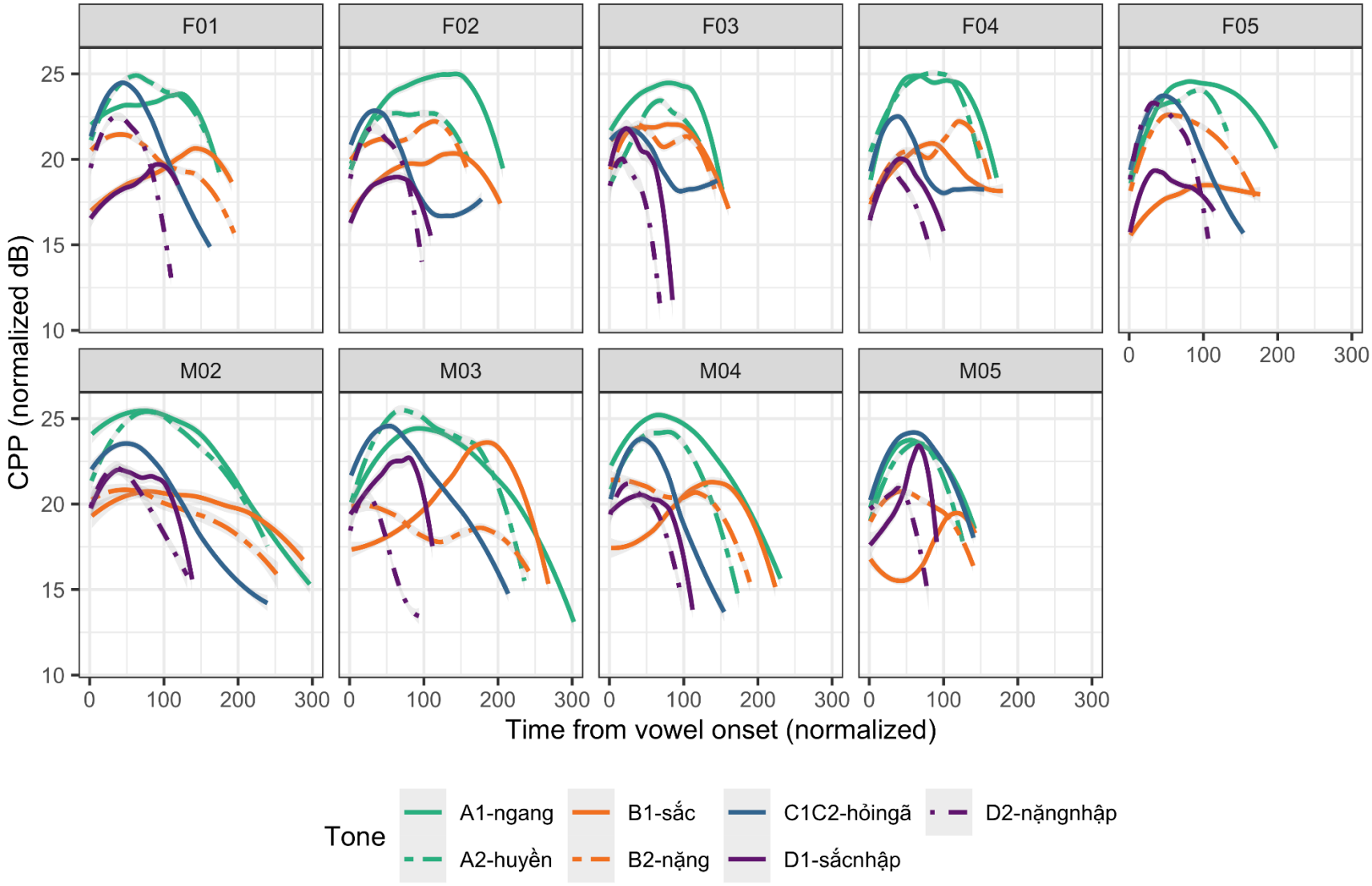
Appendix 6-12. Normalized f0 of individual tone systems in the Diêm Điền dialect.



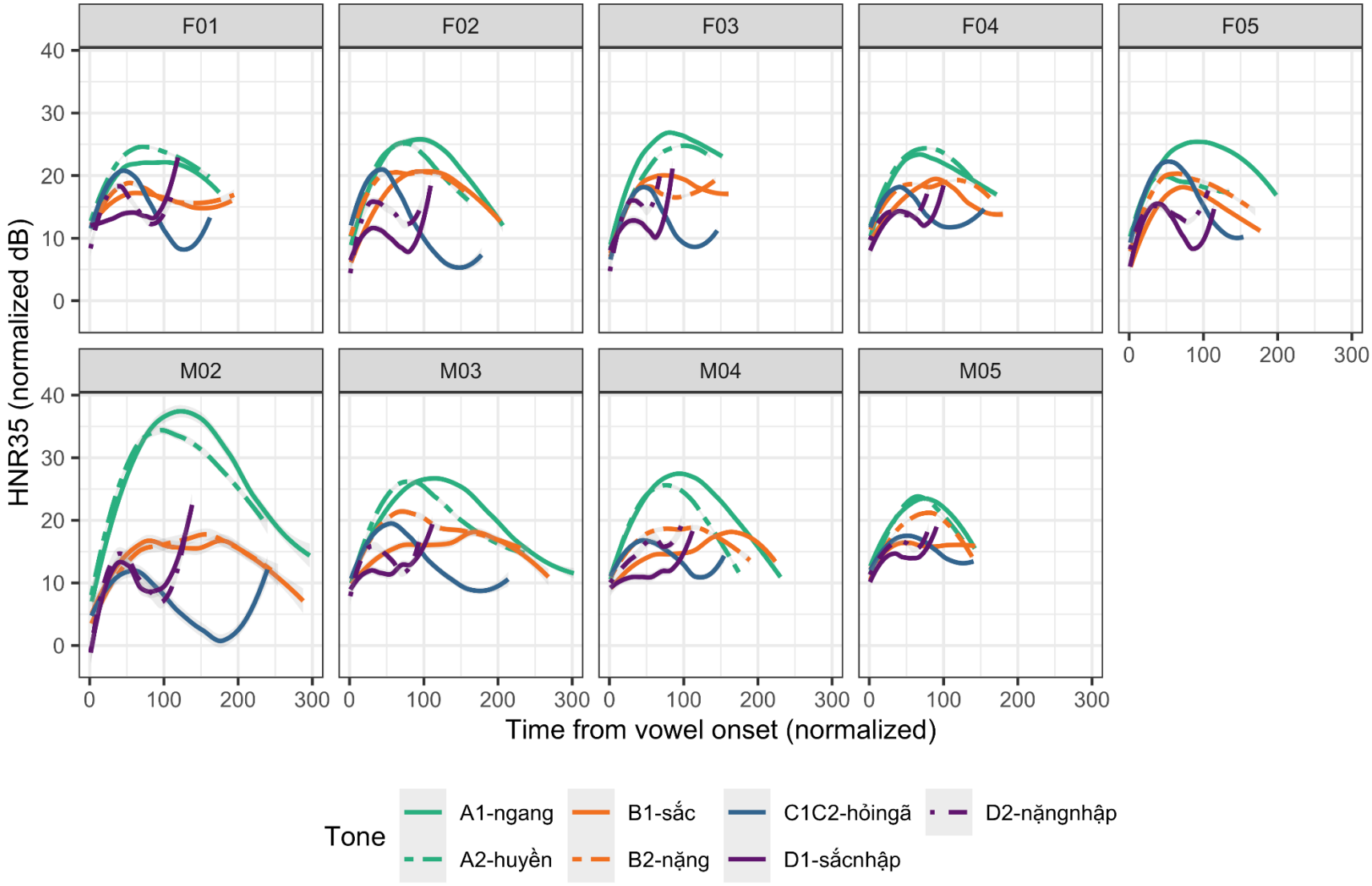
Appendix 6-13. Normalized H1*-H2* of individual tone systems in the Diêm Điền dialect.



Appendix 6-14. Normalized CPP of individual tone systems in the Diêm Điền dialect.



Appendix 6-15. Normalized HNR35 of individual tone systems in the Diêm Điền dialect.



Appendix 6-16. Results of the linear mixed model fitted to the tone duration data of the Diêm Điền dialect. Model*: Duration ~Tone*Vowel + (1|Subject).*

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	197.16	12.87	13.41	15.32	0.00***
ToneA2-huyền	-71.42	8.45	1023.08	-8.45	0.00***
ToneB1-sắc	-3.60	8.79	1023.08	-0.41	0.68
ToneB2-nặng	9.25	8.64	1023.04	1.07	0.28
ToneC1C2-hỏingã	-18.31	7.33	1023.09	-2.50	0.01*
ToneD1-sắcnhập	-116.20	8.29	1023.07	-14.02	0.00***
ToneD2-nặngnhập	-127.63	8.34	1023.07	-15.30	0.00***
Vowelu:	6.21	8.40	1023.08	0.74	0.46
Vowelɛ:	21.99	8.64	1023.05	2.55	0.01*
Vowela:	20.77	8.56	1023.02	2.43	0.02*
ToneA2-huyền:Vowelu:	24.60	11.54	1023.05	2.13	0.03*
ToneB1-sắc:Vowelu:	-44.73	12.04	1023.06	-3.71	0.00***
ToneB2-nặng:Vowelu:	-57.36	11.71	1023.03	-4.90	0.00***
ToneC1C2-hỏingã:Vowelu:	-6.58	10.02	1023.06	-0.66	0.51
ToneD1-sắcnhập:Vowelu:	5.70	11.45	1023.04	0.50	0.62
ToneD2-nặngnhập:Vowelu:	14.26	11.53	1023.04	1.24	0.22
ToneA2-huyền:Vowelɛ:	64.20	12.44	1023.11	5.16	0.00***
ToneB1-sắc:Vowelɛ:	-4.67	12.09	1023.06	-0.39	0.70
ToneB2-nặng:Vowelɛ:	-63.85	12.11	1023.04	-5.27	0.00***
ToneC1C2-hỏingã:Vowelɛ:	-42.12	10.24	1023.04	-4.12	0.00***
ToneD1-sắcnhập:Vowelɛ:	9.98	11.60	1023.03	0.86	0.39
ToneD2-nặngnhập:Vowelɛ:	11.13	11.75	1023.04	0.95	0.34
ToneA2-huyền:Vowela:	57.50	11.98	1023.05	4.80	0.00***
ToneB1-sắc:Vowela:	32.95	11.95	1023.05	2.76	0.01**
ToneB2-nặng:Vowela:	-4.65	12.10	1023.03	-0.38	0.70
ToneC1C2-hỏingã:Vowela:	-30.67	10.16	1023.02	-3.02	0.00**
ToneD1-sắcnhập:Vowela:	49.74	11.66	1023.02	4.27	0.00***
ToneD2-nặngnhập:Vowela:	34.94	11.58	1023.02	3.02	0.00**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Appendix AA: VOWELS IN VIETIC LANGUAGES

- Language data by Ferlus, made available online by the Mon-Khmer Languages Project at http://sealang.net/monkhmer/
- Tấn Tạ added the data from three North-Central Vietnamese dialects, Cổ Định (Triệu Sơn – Thanh Hóa), Nghi Ân (Nghi Lộc – Nghệ An), and Diêm Điền (Đồng Hới – Quảng Bình).
- Data arranged by proto-vowel, proto-register, and proto-coda.
- Many items were reconstructed with multiple proto-forms. For the purposes of the dissertation, the *Proto Vietic* column selects the reconstructions most related to Vietnamese dialects. The *Proto Vietic1* column includes the second most relevant reconstruction for each of these items.
- Rows marked in **orange** are vowel changes from Proto-Vietic to standard Northern Vietnamese in the *high register*, and **purple** color the *low register.*

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
										VOWEL *i:																
1	fil > tendon, thread > tendon	*cis	tɕi^{c1}				tɕin^{c1}			ci:l^{4}			ci:l^{4}	ci:l^{4}	cinʔ						ci:^{56}		ci:^{5}		ci:^{5}	
2	montrer du doigt, to point	*cih	tɕi^{c1}					sadɔ:j^{3}		kudɔ:j^{3}	cadɔ:j^{3}	kadɔ:j^{3}	cadɔ:j^{3}	kədɔ:j^{3}	idɑ:j	dɔəj	kdɔ:j	dɔ:j	*kdɔ:j^{3}	ci:^{5}	ʈɔ:^{56}	ci:^{5}	tlɔ:^{5}	klɔ:^{5}		*k-lɔh
3	singe, monkey	*k^{h}ih	xi^{c1}				vɔ:k^{D2}	mɔ:m^{4}	do:^{1}	k^{h}i:^{4}	do:^{1}	do:^{1}	moɔ̀m^{4}	moɔ̀m^{4}		vɔ:k	vɔ:k	vɔwk	*vɔ:k^{8}	k^{h}i:^{5}	k^{h}i:^{56}	wɔ:k^{8}	vɔ:k^{8}	vɔ:k^{8}	k^{h}i:^{5}	*mɔ:mʔ
4	mûr, cuit, ripe, cooked	*ci:nʔ	tɕin^{B1}					ci:n^{3}	cɪ:nʔ	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:nʔ	ci:n	ci:n	ci:n	*ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	
5	neuf (9), nine	*ci:nʔ	tɕin^{B1}					ci:n^{3}	cɪ:nʔ	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:nʔ	ci:n	ci:n	ci:n	*ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	ci:n^{3}	
6	pou de tête, head louse	*ci:ʔ	tɕəj^{B1}	tɕi^{B1}	tɕi^{B1}	tɕəj^{B1}	tɕi^{B1}	ci:^{3}	cɪ:ʔ	cəi^{3}	kə:^{3}	kə:^{3}	ci:^{3}	ci:^{3}	cɪ:ʔ	cəi	ci:	cei	*ci:^{3}	ci:^{3}	ci:^{3}	ci:^{3}	ci:^{3}	ci:^{3}	ci:^{3}	
7	paupière, eyelid	*ɓi:lʔ	mi^{B1}	mi^{B1}	mi^{B1}	mi^{B1}				kupi:^{1}			kupi:l^{1}	kupi:l^{1}				pi:l	*pi:l^{1}	bi:l^{3}	mi:^{3}		mi:^{1}	pɛ:l^{2}		
8	tendon, tendon	*k-ji:rʔ	ɣən^{A1}					kaɲi:l^{5}	kaji:rʔ	kaɲɨh^{1}										ci:l^{6}				cic^{7}		
9	porc-épic, porcupine	*k-ɲi:mʔ	ɲim^{B1}					ke:l^{1}	kę:r	ɲi:m^{3}	ji:^{1}	ji:^{1}	kəɲɨŋ^{3}	kəɲɨŋ^{3}	kaɲəŋʔ	ɲi:m	kɲi:m	ɲi:m	*kɲi:m^{3}	ɲi:m^{3}	ɲi:m^{3}		ɲi:m^{3}	ɲi:m^{3}	ɲi:m^{3}	*k-ɲɨŋʔ
10	sécher au feu, to dry on fire	*c-ri:ʔ	səj^{B1}	səj^{B1}	səj^{B1}	səj^{B1}			karɒ:ʔ	pədaŋ^{1}			cəri:^{4}	təri:^{4}	adaŋ | arɪ:ʔ	saoŋ			*sɔ:ŋ^{1}	sɔ:ŋ^{1}		so:ŋ^{1}			*tʃo:ŋ
11	aller, to go	*ti:	ɗi^{A1}								ti:^{2}		ti:^{2}	ti:^{2}	tì:	təi	ti:	tei	*ti:^{2}	ti:^{2}	ti:^{2}	ti:^{1}	ti:^{1}	ti:^{1}	di:^{1}	
12	bras, main, arm, hand	*si:	taj^{A1}	taj^{A1}	ta:j^{A1}	taj^{A1}		si:^{1}	si:^{1}	si:^{1}	si:^{1}	si:^{1}	si:^{1}	si:^{1}	tʰɪ:	səi	si:	sei	*si:^{1}	si:^{1}	si:^{1}	t^{h}aj^{1}	t^{h}aj^{1}	saj^{1}	saj^{1}	
13	ivre, be drunk	*p-ri:	saj^{A1}	saj^{A1}	sa:j^{A1}	t^{h}aj^{A1}		pəri:^{1}		pəɣi:^{1}	p^{h}ali:^{1}	maʔu:l^{1}	p^{h}ri:^{1}	p^{h}ri:^{1}	pərɪ:	p^{h}ləi	p^{h}li:	p^{h}lei	*p^{h}ri:^{1}	p^{h}raj^{1}	si:^{1}	k^{h}aj^{1}	k^{h}aj^{1}	faj^{1}	k^{h}aj^{1}	*m-ʔu:l
14	ci, ceci|this	*-ni:	naj^{A1}	ni^{A1}	ni^{A1}	nəj^{A2}										nəi	ni:	nei	*ni:^{1}	ni:^{1}	nəj^{2}					
15	aiguille, needle	*ki:m	kim^{A1}					ki:m^{1}	kɪ:m	ki:m^{1}			ki:m^{1}	ki:m^{1}	kim	ki:m	ki:m	ki:m	*ki:m^{1}	ki:m^{1}	ɣi:m^{2}	ki:m^{1}	ki:m^{1}	ki:m^{1}	ki:m^{1}	
16	jambe, pied, leg, foot	*ciŋ	tɕən^{A1}	tɕɨn^{A1}	tɕɨn^{A1}	tɕən^{A1}	tɕɨn^{A1}	ci:ŋ^{2}	ci:ŋ^{2}	ci:ŋ^{2}	ci:ŋ^{2}	ci:ŋ^{2}	ci:ŋ^{2}	ci:ŋ^{2}	cìŋ	ci:ŋ	ci:ŋ	ci:ŋ	*ci:ŋ^{2}	kaŋ^{5}		cən^{1}	cən^{1}	cən^{1}	cən^{1}	
17	oiseau, bird	*-ci:m	tɕim^{A1}	tɕim^{A1}	tɕim^{A1}	ko^{A2}		ʔo:^{3}	ʔo:ʔ	ʔo:^{3}	acɔ:j^{1}	aci:m^{1}	ci:m^{1}	ci:m^{1}	icɪ:m	ci:m	ci:m	ci:m	*ci:m^{1}	ci:m^{1}	ci:m^{1}	ci:m^{1}	ci:m^{1}	ci:m^{1}	ci:m^{1}	*ʔo:ʔ
18	nageoire, fin	*c-pi:l	vəj^{A1}	vəj^{A1}	vəj^{A1}	vəj^{A1}	vi^{A1}	səpi:^{1}			kpi:^{2}		tupi:l^{1}	pi:^{1}					*kpil^{1}	pia^{1}	pan^{1}	vəj^{1}	vəj^{1}	vəj^{1}		*c-pi:
19	naître, accoucher, to be born, give birth	*k-ri:ŋ	siŋ^{A1}																	k^{h}riŋ^{1}		k^{h}iŋ^{1}				
20	anus, anus	*ti:t	ɗit^{D1}								ti:t^{8}		tù:l^{4}			ti:t		ti:t	*ti:t^{8}	ti:t^{8}	ti:t^{8}					

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
21	peu, few	*ʔiːt	ʔit^{D1}	ʔik^{D1}	ʔit^{D1}	ʔik^{D1}		məʔit^{1}		kəʔit^{1}	ʔiːt^{7}		ʔit^{7}	ʔit^{7}		ʔiːt		ʔiːt	*ʔiːt^{7}	ʔiːt^{7}	ʔiːt^{7}					
22	s'écarter de, to draw aside	*sic	tʰat^{D1}							tʰec^{7}			sik^{7} R x	sic^{7}												
23	petit, small	*ɗiːt	nit^{D1}													diːt		diːt	*diːt^{7}	dɛːt^{7}	dɛːt^{7}					
24	hache, axe	*m-riːw	ziw^{A2}							məɣiːw^{2}			məriːw^{2}	məriːw^{2}		nɔːŋ	nɔːŋ	mlɔoŋ	*mlɔːŋ^{2} / nɔːŋ^{2}	nɔːŋ^{2}	noaŋ^{2}	kʰiːw^{2}	kʰiːw^{2}	fiːw^{2}	kʰiːw^{2}	*m-lɔːŋ
25	soeur aînée, elder sister	*ɟiːʔ	tɕi^{B2}	tɕəj^{B2}	tɕəj^{B2}	tɕi^{B2}							ciː^{4}	ciː^{4}	cìːʔ		ciː		*ciː^{4}	ciː^{4}	jiː^{4}					
26	cou, neck	*t-giːʔ	ko^{c1}										təkìː^{4}	təkiː^{4}									kɛːə^{1}	kɛːl^{1}	kɛːn^{1}	*kɛːl
27	courge cireuse (Bennicasa cerifera), gourd (Bennicasa cerifera)	*k-biːrʔ	ɓi^{B1}					səpiːl^{1}	sapìːr	binˀ^{4}	capiːn^{1}	capiːl^{1}		biːn^{3}		piːn	kpiːl	piːl	*kpiːl^{3}	piːl^{2}	biː^{3}	piːl^{3}	piːə^{3}	piːl^{3}	biːn^{3}	
28	bâton de marche, walking stick	*-giːʔ	ɣəj^{B2}	ɣaj^{B2}	ɣaj^{B2}	ɣəj^{B2}										kəi	ki:	kei	*kiː^{4}	kaj^{4} é kəj^{4}						
29	iguane (Varanus salvator), iguana (Varanus salvator)	*t-riːʔ	ki^{A2}					ʐia^{3}	ʰriaʔ		hia^{3}	hia^{3}	təriː^{3}	təriː^{3}												
30	troupeau, herd	*biː	ɓəj^{A2}													pəi		pei	*piː^{1}		peː^{3}					
31	jour, day	*-ŋiː	ŋaj^{A2}													ŋəi	ŋiː	ŋei	*ŋiː^{1}	ŋaj^{1}	ŋiː^{1}					
32	toi, tu|you (sing.)	*miː	maj^{A2}	mi^{A1}	mi^{A1}	məj^{A2}										məi	miː	mei	*miː^{2}	miː^{2}	məj^{2}					
33	regarder, to look at	*ɗiːn	ɲin^{A2}													diːn		diːn	*diːn^{1}							
34	viande, chair|meat	*-siːt	tʰit^{D2}					kahɛːkˀ^{7}	pʊːjʔ		mɛːŋ^{3}	ncɛh^{1}	sitˀ^{8}	sitˀ^{8}	tʰìːt	siːt			*siːtˀ^{8}	siːtˀ^{8}	siːtˀ^{8}	tʰiːtˀ^{8}	tʰiːtˀ^{8}	ɲukˀ^{7}	siːtˀ^{8}	
35	canard, duck	*viːt	vitˀ^{D2}					viːtˀ^{8}		viːtˀ^{8}			viːtˀ^{8}	viːtˀ^{8}		viːt	viːt	viːt	*viːtˀ^{8}	vitˀ^{8}	viːtˀ^{8}	viːtˀ^{8}	viːtˀ^{8} S viːtˀ^{8},		viːtˀ^{8}	
36	fil > tendon, thread > tendon	*cis	tɕi^{c1}				tɕinˀ^{c1}			ciːlˀ^{4}			ciːlˀ^{4}	ciːlˀ^{4}	cinʔ						ciː^{56}		ciː^{5}		ciː^{5}	
37	montrer du doigt, to point	*cih	tɕi^{c1}					sadɔːj^{3}		kudɔːj^{3}	cadɔːj^{3}	kadɔːj^{3}	cadɔːj^{3}	kədɔːj^{3}	idɑːj	dɔəj	kdɔːj	dɔːj	*kdɔːj^{3}	ciː^{5}	ʈɔː^{56}	ciː^{5}	tlɔː^{5}	klɔː^{5}		*k-lɔh
38	singe, monkey	*kʰih	xi^{c1}				vɔːk^{D2}	mɔːmˀ^{4}	doː^{1}	kʰiːˀ^{4}	doː^{1}	doː^{1}	moɔ̀mˀ^{4}	moɔ̀mˀ^{4}		vɔːk	vɔːk	vɔwk	*vɔːkˀ^{8}	kʰiːˀ^{5}	kʰiːˀ^{56}	wɔːkˀ^{8}	vɔːkˀ^{8}	vɔːkˀ^{8}	kʰiːˀ^{5}	*mɔːmʔ
	VOWEL *u:																									
39	balayer, balai, to sweep, broom	*k-cuːs	tɕoj^{c1}				tɕuj^{c1}			kəcuːɯ^{h1}				kucuːlʰ^{1}	cùːjʔ											
40	cobra, cobra	*huh	hoˀ^{c1}					salɨmˀ^{1}	cilɨm ciləm				pəsíːɲ joːŋ		mæːŋ	how	huː	how	*huː^{3}	haw^{5}			hoː^{5}	hoː^{5}		*c-lɨm
41	nid, nest	*s-ʔuh	ʔoˀ^{c1}				ʔoˀ^{c1}	suː^{56} ʔuː^{56}	sʊːʔ ʔʊːʔ	suh^{1} ʔuh^{1}			suh^{1}	ʔoː^{6}	nʊh	sow	suː	sow		sɔw^{5}	ʔoː^{56}		ʔoː^{5}	ʔoː^{5}	ʔoː^{5}	
42	souffler, to blow	*t-huːs	tʰojˀ^{c1}	tʰunˀ^{c1}	tʰojˀ^{c1}	tʰojˀ^{B2}							tʰuːrʰ^{1}	tʰuːlʰ^{1}		tuːc	tuːt	tuːc	*tuːcˀ^{8}	tʰuːl^{5}	tʰuːn^{56}		tʰoːj^{5}	hoːl^{5}		*p-liːw
43	tubercule, tuber	*kuh	kuˀ^{c1}	kuˀ^{c1}	koˀ^{B1}	kuˀ^{B2}			mărəːk				pəraːkˀ^{7}						*kuːˀ^{3}	kəw^{5}	kuː^{56}	kuː^{5}	kuː^{5}	kuː^{5}		*p-raːk
44	joyeux, joyful	*t-puːj	vujˀ^{A1}				ɓujˀ^{A1}	səpuːj^{1}		təpuːj^{1}			təpuːj^{1}	təpuːj^{1}	pʊːj	puːj	kpuːj	puːj	*kpuːj^{1}	puːj^{1}	vuːj^{1}	puːj^{1}	puːj^{1}	puːj^{1}		
45	lèvres, lips	*c-ɓuːj	mojˀ^{A1}	mujˀ^{A1}	mujˀ^{A1}	mojˀ^{A1}	mujˀ^{A1}			təboːjˀ^{3}			cəboːjˀ^{3}	cəboːjˀ^{3}				bubuːj	*kbuːj^{1}	bɔːj^{1} et	boːj^{1}	moːj^{1}	moːj^{1} moːj^{1}		moːj^{1}	
46	forer, foret, taraud|drill, tap	*k-cuːj	zujˀ^{A2}																*kcuːj^{1}	cuːj^{1}	ʐuːj^{1}			cuːj^{2}		
47	tétines, udder	*k-ɓuːj	numˀ^{B1}													bujbuːj	kbuːj	buːj	*kbuːj^{1}							

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48	genou, knee	*t-kuːlʔ	ɣojᴮ¹	kunᴮ¹	kujᴮ¹	ɣojᴮ¹	kujᴮ¹	təkuːl³	ukʊːlʔ		hakùːn³	akùːl³	təkuːl³	təkuːl³	lakuəlʔ	kunkuːn		kulkuːl	*kuːl³			koːl³			koːn³	
49	hibou, owl	*kuːʔ	kuᴮ¹					kuː³	bǫ̈ː¹		boː¹	boː¹	poː³	poː³	pɔːʔ	baw	boː	baw	*boː¹	kuː³ mɛːw²	kuː³ mɛːw²		kuː³	kaw³		*poːʔ
50	nombril, navel	*p-suːɲʔ	zonᴮ¹				zunᴮ¹	pəsuːɲ³	musʊːɲ³	tuduːɯʰ¹	pʰaɲuːɲ³	pasuːɲ³ pasuːn³	tuduːlʰ¹	duduːl³	uduh		suːn	suːɲ	*suːɲ³	suːn³	tuːn³	tʰuːɲ³	tʰuːɲ³	suːɲ³ soːɲ³	suːɲ³	*t-ɗuːs
51	ours, bear	*c-kuːʔ	ɣəwᴮ¹	ɣəwᴮ¹	ɣəwᴮ¹	ɣəwᴮ¹	ɣuᴮ²	səkuː⁴	camoːk	təkow⁴	cəkuː⁴		cəkuː⁴	cəkuː⁴	cikùːʔ	kow	kuː	kow	*tkuː⁴	kuː⁴	ɣuː⁴	kuː³	kuː³	kuː³	kuː³	
52	porc, pig	*kuːrʔ	kujᴮ¹					kuːl⁴	kùːr		kuːl⁴ kuːn⁴	kuːl⁴àkuːn⁴	kuːl⁴	kuːl⁴	kùːlʔ	kuːn	kuːl	kuːl	*kuːl⁴	kuːl⁴	ɣuːn⁴	kuːj³	kuːj³	kuːj³	kuːj³	
53	rat de bambou (Rhizomis), bamboo rat (Rhizomis)	*-tuːjʔ	zujᴮ¹					tuːj³	tuːjʔ	tuːj³			tuːj³	tuːj³	µpùːj	puːj	kpuːj		*kpuːj²	ruːj⁶		kan³	kan³	kan³	kankan³	*k-buːj
54	téter, sucer| to suck at breast	*puːʔ	ɓuᴮ¹					ʔuː³	ʔʊːʔ prnuːʔ	puːˑ⁴	ʔuː³	ʔuː³ pʰanuː³	puːˑ⁴	pupuːˑ⁴	pùːʔ	now				ʔuː³ et		puːˑ³ ʔuː³	puːˑ³ ʔuː³	puːˑ³ ʔuː³		
55	tremper, to soak	*ʃuːŋʔ	ɲuŋᴮ¹						tèm	ɲuːtˀ⁷	tèm²	tèm²	ɟuŋ³	ɟuːŋ³	ɲʊːŋʔ					ɲuːŋ³	ɲuːŋ³	juːtˀ⁷		juːtˀ⁷		*ʃuːt
56	chignon, bun	*c-puːlʔ	ɓujᴮ¹	ɓunᴮ¹	ɓojᴮ¹	ɓujᴮ¹		puːl³		təpuːl³	puːl²		cəpuːl³	cəpuːl³		nun	knul	nɔl	*knul³								
57	petit fils, petite fille|grandchild	*cuːʔ	tɕawᴮ¹					cuː³	cʊːʔ	cuː³	coː³	coː³	cuː³	cuː³		caw	caw	caw	*caw³	caw³	cuː³		caw³	caw³	caw³	
58	chaud, hot	*p-ɗuŋʔ	nɔŋᴮ¹								pʰadɔŋ³	paloŋ³ pʰadɔŋ³				pʰloŋ		pʰloŋ	*pʰruŋ³	duŋ³	duŋ³	nɔːŋ³	nɔːŋ³	nɔːŋ³	nɔːŋ³	*p-ruŋʔ
59	sombre, soir, dark, evening	*suːlʔ	tojᴮ¹	tunᴮ¹	tujᴮ¹	tujᴮ¹										suːn	suːl	suːl	*suːl³	suːl³	soːn³	tʰoːl³	tʰoːə³	soːl³		
60	pourri, rotten	*tʰuːlʔ	tʰojᴮ¹	tʰunᴮ¹	tʰujᴮ¹	tʰujᴮ¹										tʰuːn		tʰuːl	*tʰuːl³	tʰuːl³	tʰuːn³					
61	torsader en chignon, to plait (hair)	*puːlʔ	ɓujᴮ¹													pun		pɔl	*pul³		puːj³					
62	forêt, forest	*m-ruːʔ	zuᴮ¹	zəŋᴬ²	zɨŋᴬ²	zɨŋᴬ²	zuᴮ¹	bəruː³ məruːˑ⁴		məɣowˑ⁴	kʰələŋ¹		bruː³	bruː³	brawʔ							şuː³	rəŋ²	rɨŋ²	thəŋ²	Âɨŋ²	*k-rəŋ
63	six, six	*p-ruːʔ	sawᴮ¹	sawᴮ¹	Sæwᴮ¹	tʰawᴮ¹		pəraw³	parawʔ	pəɣaw³	pʰaluʔ	aluʔ	ʃaw³	ʃaw³	pərawʔ	pʰlaw	pʰlaw	pʰlaw	*pʰraw³	pʰraw³	şaw³	kʰaw³	kʰaw³	faw³	kʰaw³	
64	sève, sang, sap, blood	*t-muːʔ	mawᴮ¹	mawᴮ¹	mæwᴮ¹	mawᴮ¹								təmuːˑ³						maw³			maw³		maw³	
65	crocodile, crocodile	*k-ruːʔ	səwᴮ¹	səwᴮ¹	səwᴮ¹	tʰəwᴮ¹														klowˑ⁴		kʰuː³	saw³	kʰuː³		
66	montagne, mountain	*b-ruːʔ	zuᴮ¹													pʰlow	pʰluː	pʰlow	*pʰruː³		nuːj³	toːl²	toːə² S toːl²,		doːn²	*doːl
67	balle de riz, rice husk	*k-luːʔ	tɕəwᴮ¹	tɕuᴮ¹	tɕuᴮ¹	təwᴮ¹										klowklow		koklow	*kluːˑ⁴	kluːˑ⁴	ʐuːˑ⁴		raːpˑ⁸			
68	tétines, traire, teats, to milk	*-nuːmʔ	numᴮ¹																	nuːm³	nuːm³					
69	bru, daughter in law	*-juː	zəwᴬ¹				zuᴬ¹	ujuːˑ¹	ujʊː	uzowˑ¹	kamɛnˑ¹	maːjˑ⁴	juːˑ¹	juːˑ¹	mpɨːʔ	ʔuːj	ʔuːj	ʔuːj	*ʔuːjˑ¹	beːˑ⁵	ðuːˑ¹	juːˑ¹	juːˑ¹	juːˑ¹	juːˑ¹	juːˑ¹	*bəːʔ
70	porter (chapeau), wear (hat)	*s-ɗuː	ɗojᴮ²					saduːˑ¹					taduːˑ¹	taduːˑ¹	ndaw			dow	*kduː³							
71	bosse (du zébu), hump (of zebu)	*ʔuː	ʔuᴬ¹					ʔuːˑ¹		ʔuːˑ¹			ʔuːˑ¹							ʔuːˑ¹	ʔuːˑ¹		ʔuːˑ¹	ʔuːˑ¹		
72	tourterelle, dove	*t-kuː	kuᴬ¹					təkuːˑ¹	təkʊː	kukuːˑ¹	pakuːˑ¹	takuːˑ¹	kukuːˑ¹	kukuːˑ¹		kukuː	kukuː	kowkow	*kuːˑ¹	kuːˑ²	kuːˑ¹		kuːˑ¹	kuːˑ¹	kuːˑ¹	
73	hameçon, hook	*kuː	kəwᴬ¹													kow	kuː	kow	*kuːˑ¹	kʌwˑ¹	kawˑ¹		kawˑ¹	kawˑ¹		
74	buffle, buffalo	*c-luː	tɕəwᴬ¹	tɕuᴬ¹	tɕuᴬ¹	təwᴬ¹	tɕuᴬ¹	səluː	cilùː	səlowˑ¹				tluːˑ¹	tariɛk	klow	kluː	klow	*kluːˑ¹	kʰrɔwˑ¹	ʈuːˑ¹	tluːˑ¹	kluːˑ¹	kluːˑ¹	ʈuːˑ¹	
75	profond, deep	*c-ruː	səwᴬ¹	suᴬ¹	suᴬ¹	tʰuᴬ¹	suᴬ¹	səruː		kəɣuːˑ²	tʰuːˑ²		ʈuːˑ²	ʈuːˑ²	cirùː	kʰlow	kʰluː	kʰlow	*kʰruːˑ²	kʰluːˑ²	şuːˑ²	kʰuːˑ¹	kʰuːˑ¹	kʰuːˑ¹	kʰuːˑ¹	
76	roseau, reed	*k-luː	lawᴬ¹	sajᴮ²	sajᴮ²	səjᴮ²		saluːˑ¹							alaw				*kʰruːˑ¹	pɔːl³ lawˑ¹	sajˑ⁴	pʰeːˑ³	kʰeːˑ³	lawˑ¹ | pʰeːˑ³		*p-reːʔ

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77	bêler, bleat	*k-ruː	zu^{B1}													kʰlow			*kluː^{4}							
78	chaux, lime	*k-puːr	voj^{A1}	voj^{A1}	voj^{A1}	voj^{A1}	ɓoj^{A1}	kəpoːl^{1}		kəpuːɯ^{1}	kəpuːl^{1}		kəpuːl^{1}	kəpuːl^{1}	apʊːl	puːn		puːl	*puːl^{1}	puːl^{1}	ɓəoːj^{1}	poːl^{1}	poːl^{1}	poːl^{1}	boːn^{1}	
79	sentir, embrasser, to feel, to kiss	*huːɲ	hon^{A1}					hoːɲ^{1}						huːɲ^{1}		huːɲ	huːn	huːɲ	*huːɲ^{1}							
80	aveugle, blind	*tuːl	ɗuj^{A1}														tuːl		*tuːl^{2}			tuːl^{1}		tuːl^{1}		
81	enfumer, sécher au feu, to smoke, to dry on fire	*ʔuːl	ʔun^{A1}																			ʔuːl^{1}		ʔuːl^{1}		
82	gorgée, mouthful	*ɓuːm	mum^{A1}													buːm		buːm	*buːm^{1}							
83	ver de terre, earthworm	*p-luːn	zun^{A1}				tɕun^{A2}	puluːn^{2}	pəlùːn	pəluːn^{2}		maluːn^{2}	təlaɲʔ	təlaɲʔ	alaɲʔ	pleːn	pleːl	pleːl	*pleːl^{4}	pluːn^{2}		kʰuːn^{1}	kʰuːn^{1}	fuːn^{1}	ʈuːn^{1}	*t-laɲʔ
84	sycomore (Ficus glomerata), sycamore (Ficus glomerata)	*t-ruːŋ	suŋ^{A1}					tăruːŋ^{1}													ʂuːŋ^{1}		kʰuːŋ^{1}	kʰuːŋ^{1}		
85	trembler, to shiver	*-ruːn	zun^{A1}													ɣuːn		ʰluːn	*ruːn^{1}	ruːn^{1}	ʂuːn^{1}					
86	arbre à amadou, tree tinder	*ʃuːk	ɲuk^{D1}												ɟʊk											
87	cheveux, poil, plume, head-hair, hair, feather	*-suk	tɔk^{D1}	tak^{D1}	tak^{D1}	tɔk^{D1}	tɔk^{D1}	usuk^{7}		usuk^{7}	sɔk^{7} / hasɔk^{7}	sɔk^{7} / asɔk^{7}	usuk^{7}	suk^{7}	utʰʊk	sok	suk	sok	*suk^{7}	suk^{7}	sok^{7}	tʰak^{7}	tʰak^{7}	sak^{7}	sak^{7}	
88	entre noeud, inter-node	*tuːc	ɗot^{D1}					tuːt^{1}			tuːt^{1}		pətuːt^{1}	pətuːt^{1}	utʊːt			tuːt					to:c^{7}	toːc^{7}	toːt^{7}	
89	fumer, to smoke	*ʃuːp	hut^{D1}					duːp^{7}	dʊːp		duːp^{7}	duːp^{7}	juːp^{7}	juːp^{7}	ɟʊːp	duːp	duːp	duːp	*duːp^{7}							*ɗuːp
90	puiser, to draw water	*ɓuːk	muk^{D1}										buːk^{7}		bʊk	baok	boːk	bɔːk	*boːk^{7}	buk^{7}	buːk^{7}		buːk^{7}	buːk^{7}	vuːk^{7}	
91	sucer, to suck	*c-ɓuːc	mut^{D1}										abuːc^{7}	abuːc^{7}	cibuːc	ŋɔm	ŋɨm	ŋɔm	*ŋɨm^{4}	buːt^{7}						*ŋəmʔ
92	dernier (-né), last born	*ʔuːc	ʔut^{D1}						rdʊc	kaduc^{7}			kaduːc^{7}							ʔuːt^{7}		ʔuːc^{7}	ʔuːc^{7}	ʔuːc^{7}		*k-ɗuːc
93	allumer le feu, to light a fire	*tuːc	ɗot^{D1}	ɗot^{D1}	ɗot^{D1}	ɗot^{D1}		tuːc^{7}		tuːt^{7}	tuːt^{7}												toːc^{7}	toːc^{7}		
94	bouchon, cork	*t-n-uːt	nut^{D1}													snuːt		knuːt	*snuːt^{8}		nuːt^{7}					
95	piquer (abeille), to sting (bee)	*suːt	ɗot^{D1}													suːt		suːt	*suːt^{7}							
96	boucher (trou, bouteille), to plug (hole, bottle)	*tuːt	ɗut^{D1}															suːt	*suːt^{7}	suːt^{8}						
97	grain de beauté, beauty mark (mole)	*nuːt	not^{D1}													muːt			*muːt^{8}		nuːt^{7}					
98	pangolin (Manis javanicus), anteater (Manis javanicus)	*k-ruːt	tɕut^{D1}													kʰluːt	kʰluːt	kʰluːt	*kʰruːt^{7}	kʰruːt^{7}	ʈuːt^{7}					
99	haricot, beans	*duh	ɗo^{c2}	ɗo^{c2}	ɗɔ^{B2}	ɗo^{B2}					tuh^{2}	tuh		kăjaːŋ^{3}	doːʔ					doː^{4}	doː^{4}	təw^{46}	taw^{4}	taw^{46}	daw^{46}	*duːʔ
100	nez, nose	*muːs	muj^{c2}				muj^{B2}	muːj^{5}	mùːjʔ	muːɯ^{h}	muːj^{h1}		muːl^{h1}	muːl^{h1}	mùh	muːc	muːt	muːc	*muːc^{8}	muːl^{6}	muːn^{56}	muːj^{46}	muːj^{6}	muːj^{46}	muːj^{46}	
101	tomber de soi-même, to fall (intr)	*ruh	zu^{c2}					ruj					ruh^{2}	ruh^{2}	rùh											
102	essuyer, torcher|wipe	*ɟuːj	tɕuj^{A2}									kɔjʰ^{1}								cuːj^{2}		cuːj^{2}	cuːj^{2}	cuːj^{2}		

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103	s'asseoir, to sit down	*ŋu:j	ŋojᴬ²													ŋo:j	ŋo:j	ŋu:j	*ŋu:j²	ŋo:j² et	ŋo:j²		ŋo:j²	ŋo:j²	ŋo:j²	
104	cadet de la mère/épouse, younger broth's moth/wife	*gu:ʔ	kəwᴮ²	kəwᴮ²	kəwᴮ²	kuᴮ²	kuᴮ²	ku:⁴		ku:⁴			kù:⁴	kù:⁴	kù:ʔ				*ku:⁴	ku:⁴			kaw⁴	ku:⁴⁶	ku:⁴⁶	
105	mamelle, sein|xxx, breast	*k-bu:ʔ	vuᴮ¹				vuᴮ²	panu:⁴	prnu:ʔ	pənu:⁴	pʰanu:³	pʰanu:³	nɔ:j⁴			now	nu:	now		ʔu:³ et		pu:³	pu:³	pu:³		
106	touffe, clump	*bu:lʔ	ɓujᴮ²							pu:j⁴			pù:j⁴	pù:j⁴		pu:j	pu:j	pu:j	*pu:j⁴	pu:j⁴	fu:j²	pu:l⁴⁶	pu:ə⁴ S pu:l⁴⁶,		bu:n⁴	
107	ventre, estomac, belly, stomach	*buŋʔ	ɓuŋᴮ²					kudəl¹		kudəl¹			kudəl¹ | kŭdʌl¹	kudəl¹ | kədʌl¹		poŋ		poŋ	*puŋ⁴	du:l³						*k-ɗəlʔ
108	poussière, dust	*bu:lʔ	ɓujᴮ²							pulpu:l⁴										bu:j⁴ et	bu:j⁴		pu:ə⁴	pu:l⁴	bu:n⁴	
109	fuir, goutter, to leak, drip	*ruŋʔ	zuŋᴮ²													ʰloŋ		ʰloŋ	*ruŋ⁴			ruŋ⁴⁶				
110	boire, to drink alcohol	*ŋu:ʔ	ŋəwᴮ²																							
111	huile, oil	*-tu:	zəwᴬ²	zawᴬ²	zawᴬ²	zəwᴬ²	zuᴬ²	ntu:¹	ntʊ:	təw¹	hatu:¹	atu:¹	jaw²	jaw²	jèw					jʌw²	jaw²	jəw²	jaw²			
112	trou > anus, hole > anus	*-su:	loᶜ²								hasu:¹	asu:¹														
113	gourde calebasse (Lagenaria), Indian gourd (Lagenaria)	*bu:	ɓawᴬ²	ɓawᴬ²	ɓuᴬ²	ɓəwᴬ²														pu:²		pu:²	baw²	bəw²	bu:²	
114	guêpe, frelon, wasp, hornet	*bu:	ɓawᴬ²				ɓuᴬ²													ʔɒ:ŋ¹ pu:²		pu:²	pu:²		bu:²	
115	bétel, betel	*b-lu:	tɕəwᴬ²				tɕuᴬ²	pəlu:²	plu:²	pəlow²	pəlu:²			plu:²	ulèw	plow	pʰu:	plow	*plu:²	plu:²	ʐu:²	tlu:²	pu:²	plu:²	ʈu:²	
116	creuser, to dig	*du:ɲ	ɗa:wᴬ²										tu:ɲ²	tu:ɲ²	tù:ɲ	ca:	ca:	ca:	*ca:³	ca:⁵						*tʃe:ʔ
117	boue, limoneux, mud, silt	*bu:l	ɓunᴬ²										pu:n²							pu:l²	vu:n²	pu:n²	pu:n² S pu:n²,			
118	empaqueter, to wrap	*du:m	ɗumᴬ²													tu:m	tu:m	tu:m	*tu:m²							
119	dard, stinger (of insect)	*s-n-u:t	nɔkᴰ²															nu:t	*nu:t⁸					klɛ:²		
120	dizaine, ten	*ɟu:k	tɕukᴰ²												ɲcùk											
121	fouiller du groin, nuzzle	*du:c	sukᴰ²													tu:c		tu:c	*tu:c⁸							
122	inonder, to flood	*p-lu:t	lutᴰ²							lu:t⁸			blut¹	blut¹	lù:t					lu:t⁸	lu:t⁸			lu:t⁸	lu:t⁸	
123	chair, viande|meat	*k-ɲuk	ɲukᴰ²					kahɛ:k⁷			hamo:ŋ¹	amo:ŋ¹	amo:ŋ				mɔ:ŋ	mɔ:ŋ	*kɲuk⁷			ɲuk⁷	ɲuk⁷	ɲuk⁷		*k-hɛ:k
VOWEL *e:																										
124	briser, éclater, break, burst	*-peh	ɓeᶜ¹					pɛ:⁵		pɛh¹	pih²		peh¹	peh¹		pe:	kpe:	pe:	*kpe:⁴			pe:⁵	pe:⁵	pe:⁵	be:⁵	
125	mer, aval, sea, downstream	*pes	ɓeᶜ¹																	pe:⁵	be:⁵⁶	pe:⁵	bien⁵ S pe:⁵,			
126	réservoir, retenue d'eau, tank, water storage	*peh	ɓeᶜ¹	ɓeᶜ¹	ɓeᶜ¹	ɓeᶜ¹	ɓeᶜ¹													pe:⁵		pe:⁵	be:⁵ pe:⁵,			
127	appeler qu'un, to call	*ke:w	kewᴬ¹													kɛ:w	ke:w	kɛ:w	*ke:w¹							

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128	loutre, otter	*p-se:ʔ	za:j^{B1}					maɲa:n^{1}	maɲa:n^{1}	ɲa:n^{1}	pasə:^{3}	pasə:^{3}	pəse:^{3}	pəse:^{3}	ut^{h}e:ʔ		se:		*pse:^{3}	ne:k^{8}	ʐa:j^{3}		t^{h}a:j^{3}	sa:j^{3}	ʐa:j^{3}	*m-ɲa:n
129	urine, urine	*-te:ʔ	ɗa:j^{B1}	ɗəj^{B1}	ɗəj^{B1}	ɗa:j^{B1}	ɗa:j^{B1}	te:^{3}	trnę:ʔ	te:^{3}	k^{h}aʔɔ:^{3}	taʔɔ:^{3}	ti:^{3}	ti:^{3}	ite:ʔ	taɛ	te:	tae	*te:^{3}	te:^{3}	ðia^{3}	ta:j^{3}	ta:j^{3}	ta:j^{3}	da:j^{3}	*t-rn-ne:ʔ
130	goûter, to taste	*ɗe:mʔ	nem^{B1}					de:m^{3}	dę:mʔ	de:m^{3}			je:m^{3}	je:m^{3}					*si:m^{2}	de:m^{3}	de:m^{3}	de:m^{3}	de:m^{3}	de:m^{3}	re:m^{3}	
131	grillon, cricket	*-te:lʔ	zɛ^{B1}					tumu:t^{7}			kamu:t^{7}					mɔkmɔ:k^{7}	k^{h}mɔ:k^{8}	mɔkmɔ:k^{7}	*kmɔ:k^{7} ^{8}		ðia^{3}	tiɛl^{3}	teə^{3}	tiɛl^{3}		*k-mɔ:k
132	carambole, carombola	*k^{h}e:ʔ	xe^{B1}													k^{h}aɛ		k^{h}ae	*k^{h}e:^{3}		k^{h}e:^{3}					
133	fruit, fruit	*p-le:ʔ	tɕa:j^{B1}	tɕəj^{B1}	tɕəj^{B1}	ta:j^{B1}	tɕa:j^{B1}	pəle:^{3}	plɪ:ʔ	pəle:^{3}	p^{h}alə:^{3}	p^{h}lə:^{3}	pəli:^{3}	pəli:^{3}	ule:ʔ	plaɛ	ple:	plae	*ple:^{3}	ple:^{3}	ʈe:^{3}	tla:j^{3}	pla:j^{3}	pla:j^{3}	tla:j^{3}	
134	prendre, to take	*le:ʔ	ləj^{B1}	ləj^{B1}	ləj^{B1}	nəj^{B1}	ləj^{B1}									le: nɔm	le:^{3}	le:	*le:^{4}		le:^{4}		le:^{4}	le:^{46}	le:^{46}	*-nəmʔ
135	cerf, stag	*k-ɗe:	na:j^{A1}	na:j^{A1}	n^{w}a:j^{A1}	na:j^{A1}	na:j^{A1}	kədi:^{1}	kdɪ:	kədi:^{1}	kədi:^{1}	maja:w^{2}	kədi:^{1}	kədi:^{1}	kəde:	daɛ	kde:	dae	*kde:^{1}		de:^{1}	da:j^{1}	ra:j^{1}	da:j^{1}	na:j^{1}	
136	chèvre, goat	*-te:	zɛ^{A1}																	te:^{1}	ðia^{1}	te:^{1}	te:^{1}	te:^{1}	ɗe:^{1}	
137	décortiquer, to husk rice	*tʃe:	saj^{A1}																	saj^{1}		saj^{1}	saj^{1}	saj^{1}		
138	qui, who	*ʔe:	ʔa:j^{A1}													ʔaɛ	ʔe:	ʔae	*ʔe:^{1}	ʔe:^{1}	ʔe:^{1}		ʔa:j^{1}	ʔa:j^{1}		
139	ramie, ramie	*-ke:	ɣa:j^{A1}													k^{h}lʌŋ	k^{h}liŋ	k^{h}lɛŋ	*k^{h}riŋ	ke:^{1}	ke:^{1}		ka:j^{1}	ka:j^{1}		*k-rəŋ
140	épine, thorn	*t-ke:	ɣa:j^{A1}	kəj^{A1}	ɣəj^{A1}	ɣa:j^{A1}	ɣa:j^{A1}									kaɛ	tke:	kae	*tke:^{1}	ke:^{1}	ɣa:j^{1}					
141	remuer, délayer, stir, mix	*kwe:	k^{w}aj^{A1}	k^{w}aj^{A1}	k^{w}a:j^{A1}	k^{w}aj^{A1}	k^{w}aj^{A1}									kwaɛ	kwe:	kwaɛ	*kwe:^{1}							
142	tamis, tamiser, sieve, sift	*-re:	zəj^{A1}	zəj^{A1}	zəj^{A1}	zəj^{A1}	zəj^{A1}													re:^{1}		rəj^{1}	ʐəj^{1}	t^{h}əj&^{1}		
143	cuisse, thigh	*t-pe:l	ve^{B1}					təpe:l^{1}	tapę:l^{1}	təpe:l^{1}	məlù:^{2}	malù:^{2}	pulu:^{1}	pəlu:^{1}	ulaw				*kpa:^{3}					blu:^{1}		*m-lu:
144	cloison tréssée, bamboo panel	*pe:l	fen^{A1}													tɔŋ	tɨŋ	tʌŋ	*tɨŋ^{3}	təŋ^{3}		pe:l^{1}		pe:l^{1}	dɨŋ^{3}	*təŋʔ
145	nuit, night	*te:m	ɗem^{A1}													tɛ:m	te:m	taem	*te:m^{1}	te:m^{1}	te:m^{1}					
146	monter, to mount	*le:ɲ	lem^{A1}	len^{A1}	len^{A1}	nen^{A1}	len^{A1}						li:ŋ^{1}	li:ŋ^{1}	ləːŋ	lɛːŋ	le:ŋ^{1}	lɛːɲ	*le:ŋ^{1}	le:n^{1}	le:n^{1}	le:ɲ^{1}	le:n^{1}	le:ɲ^{1}	le:n^{1}	
147	limace, slug	*p-re:n	sen^{A1}											tlɔ:^{3}									k^{h}e:n^{1}	fe:n^{1}		*k-lɔ:ʔ
148	carambole (Averrhoa carambola), starfruit (Averrhoa carambola)	*k-le:l	xe^{B1}	xe^{B1}	xe^{B1}	xe^{B1}	xe^{B1}	kure:l^{1}												kle:l^{1}	k^{h}e:^{3}	tle:l^{1}	k^{h}e:^{3}	kle:l^{1}		
149	village, village	*k-ve:r	k^{w}e^{A1}	k^{w}e^{A1}	k^{w}e^{A1}	k^{w}e^{A1}	k^{w}e^{A1}	vi:l		kəve:l^{1}			kəve:l^{1}	kəve:l^{1}	vì:l									kwe:l^{1}	kwe:l^{1}	
150	(riz) glutineux, glutinous (rice)	*ɗe:p	nep^{D1}	nep^{D1}	nep^{D1}	nep^{D1}	nep^{D1}	de:p^{7}	dę:p	de:p^{7}			de:p^{7}	de:p^{7}	di:p				*ɲɛ:l^{4}	de:p^{7}	de:p^{7}	de:p^{7}	re:p^{7}	de:p^{7}	re:p^{7}	
151	mourir, to die	*k-ce:t	tɕet^{D1}	tɕet^{D1}	tɕet^{D1}	tɕet^{D1}	tɕet^{D1}	kəce:t^{7}		kɨce:t^{7}	cə:t^{7}		kəci:t^{7}	ci:t^{7}	cɪ:t	ce:t	ce:t	ce:t	*ce:t^{7}	ce:t^{7}	ce:t^{7}		ce:t^{7}	ce:t^{7}	ce:t^{7}	
152	tuer, to kill	*kə-ce:t	ziət^{D1}					ziɛt^{7} Pk kəcɛ:t^{7}		kace:t^{7}			kuci:t^{7}	kəci:t^{7}	kəci:t	ɟiɛt^{7}	pce:t	-ce:t	*pce:t^{7}	jiɛt^{7}	jiɛt^{7}					
153	grenouille, frog	*ʔe:k	ʔek^{D1}						kòɔt							ʔaek			*ʔe:k^{7}	be:k^{7}	ʔe:k^{7}		ʔe:k^{7}	ʔe:k^{7}	ʔe:k^{7}	
154	centipède, centipede	*-se:t	zet^{D1}	zik^{D1}	zit^{D1}	tik^{D1}	zet^{D1}														ʐe:t^{7}	t^{h}e:t^{7}	t^{h}e:t^{7}	se:t^{7}		
155	fini, terminé|finished	*he:t	het^{D1}													haɛt			*he:t^{7}	he:t^{7}		he:t^{7}		he:t^{7}		
156	conduire à la longe, to lead w. a rope	*te:k	tek^{D1}													taek			*te:k^{7}				x S o,			

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157	épouse, wife	**-bəːʔ	vəᴮ²					keː³ (kɨl)	kẹːʔ (-kɨl)	ukeː³			məkiː³	pəkiː³ (ʈɨː²)	keːʔ	kaɛ		kae	*keː³	mɔː⁴	moa⁴	vəː⁴⁶	vəː⁴	bəː⁴⁶		p-keːʔ
158	araignée, spider	*ɲeːɲʔ	ɲenᴮ²										tɔːc⁷		tɑːc					ɲeŋ⁴	ɲeːn⁴		zeːɲ⁴	zeːɲ⁴	zeːɲ⁴	*tɔːc
159	mère > femelle, mother > female	*meːʔ	mɛᴮ²	mɛᴮ²	mʲɛᴮ²	maᴮ²	mɛᴮ²	meː⁴	mèːʔ	miː⁴	məː⁴	məː⁴	mèɛ⁴	mèɛ⁴	nùːn	meː	meː	meː	*meː⁴	meː⁴	meː⁴	meː⁴⁶		meː⁴⁶	meː⁴⁶	
160	pilon, pestle	*tʃ-reː	tɕajᴬ²	tɕajᴬ²	tɕaːjᴬ²	tɕajᴬ¹	tɕajᴬ²	səreː¹	sarẹː	ɣeː²	ahəː¹		nriː¹	əriː¹	nrɪː	ɣaɛ	ʰleː	ʰrae	*reː¹	reː¹	ʈeː¹		kʰajˀ	kʰajˀ	kʰajˀ	
161	amarante épineuse (Lasia spinosa), spiny amaranth (Lasia spinosa)	*-ceːɲ	zənᴬ²																				ceːn¹	ceːɲ¹		
162	rentrer, to return	*veːr	veᴬ²	viənᴬ²	veᴬ²	veᴬ²	veᴬ²	veːlˀ	vèːr		vɔɔlˀ		viː²	viː²			veːl	veːl	*veːlˀ	veːlˀ	viɛnˀ		veː²	veːlˀ	veːlˀ	
163	punaise (de lit), (bed)bug	*-reːp	zepᴰ²							yeːp⁸			reːp⁸	reːp⁸							seːp⁸			tia¹		
	VOWEL *ə:																									
164	confier, envoyer, to entrust, send	*p-kəːs	ɣɨjᶜ¹	ɣɨjᶜ¹	ɣɨjᴮ¹	ɣəːjᴮ²	ɣəːjᶜ¹			pakəːj³			pakɨəj⁴	pakɨəj⁴	pakəːjʔ	kaəj		kaəj	*kəːj³	kəːj⁵	ɣɨəj⁵⁶	kəːj⁵	kəːj⁵	kəːj⁵		
165	ouvrir (la porte), open (the door)	*pəh	məᶜ¹					pəːᵛ⁵⁶		pəh					pòh				*bəːᐟ³				pəːᐟ⁵			
166	sept, seven	*pəs	ɓajᶜ¹					pajᐟ⁵			pihˀ¹		pajᐟ⁶	pajᐟ⁶	pʌh	bajᐟ³	pal	pal	*palᐟ³	pajᐟ⁵	pajᐟ⁵⁶	pajᐟ⁵	pajᐟ⁵	pacˀ¹	bajᐟ⁵	
167	respirer, to breathe	*tʰəh	tʰəᶜ¹					tənɟɨːᐟ⁵	taŋəːʔ			pasəːmˀ³	təŋəhˀ¹	təŋəhˀ¹		tʰaə	tʰəː	tʰaə	*tʰəːᐟ³	tʰəːᐟ⁵ | ŋɨəjᐟ⁶	tʰəːᵛ⁵⁶	tʰəːᐟ⁵	tʰəːᐟ⁵	səːᐟ⁵		*t-ŋəs
168	ouvrir (porte, oeil, bouche), to open (door, eye, mouth)	*ɓəh	məᶜ¹						bəlaŋ													bəːᐟ⁵		bəːᐟ⁵	vəːᐟ⁵	
169	demeurer, être, to stay, to be	*ʔəh	ʔəᶜ¹													ʔaə	ʔəː T,		*ʔəːᐟ³	ʔəːᐟ⁵	ʔəːᵛ⁵⁶		ʔəːᐟ⁵			
170	retourner, revenir|return	*p-ləh	tɕəᶜ¹	kʷajᴬ¹	kuəᴬ¹	kʷajᴬ¹										plaə			*pləːᐟ³	pləːᐟ⁵	ʈəːᵛ⁵⁶	tləːᐟ⁵				
171	haleine, souffle|breath	*həːj	həːjᴬ¹																	həːjˀ¹			həːjˀ¹	həːjˀ¹		
172	se lever, dresser, debout, to get up, dresser, stand up	*təŋʔ	ɗɨnᴮ¹					tɨŋᐟ³		tɨŋᐟ³			tɨŋᐟ⁶	tɨŋᐟ⁶	tɨŋʔ	tɔŋ	tɨŋ	tʌŋ			tɨŋᐟ⁴					
173	serpent, snake	*p-səɲʔ	zanᴮ¹					tanᴮ¹	səjaːlᐟ³	səjaːrʔ	ajaːɯᐟ³	lukᐟ⁸		pəsiɲᐟ³	pəsiɲᐟ³	utʰiɲʔ	sʌɲ	siŋ	sɛɲ	*siɲᐟ³	siŋᐟ³	siɲᐟ³	tʰaɲᐟ³	tʰaɲᐟ³	saɲᐟ³	saɲᐟ³	*s-jaːrʔ
174	tiède, lukewarm	*s-ʔəmʔ	ʔəmᴮ¹					taʔɨmᐟ³		ʔʌmʔʌmᐟ³	tiŋˀ¹	tiŋˀ¹	tiɲˀ¹	tiɲˀ¹	ʔʌmʔʌmʔ	paoŋ	poːŋ	pɔːŋ	*sʔɨmᐟ³	ʔʌmᐟ³	ʔʌmᐟ³	ʔəmᐟ³	ʔəmᐟ³	ʔəmᐟ³		*tiŋ
175	tirer, to shoot	*pəɲʔ	ɓanᴮ¹					piɲᐟ³		piɲᐟ³	piɲᐟ³		piɲᐟ³	piɲᐟ³	piɲʔ	pʌɲ	piŋ	pɛɲ	*piɲᐟ³	piŋᐟ³	piɲᐟ³	paɲᐟ³	paɲᐟ³	paɲᐟ³	baɲᐟ³	
176	péter, to fart	*k-səmʔ	zamᴮ¹						prsət				pusətˀ⁷				ksum	sɔm	*ksumᐟ³	sʌmᐟ³			tʰamᐟ³	saːmᐟ³	samᐟ³	
177	repiquer, transplanter|to transplant rice seedlings	*kəlʔ	kəjᴮ¹											kəlᐟ³						kʌlᐟ³	kʌnᐟ³	kəlᐟ³	kaəᐟ³	kəlᐟ³	kənᐟ³	
178	cheveux, hair	*kəːjʔ	tɔkᴰ¹					kəːjᐟ³	kʌːjʔ	kəːjᐟ³																
179	nouveau, new	*ɓəːjʔ	məːjᴮ¹													bəːj	bəːj	bəːj	*bəːjᐟ³	bəːjᐟ³	bəːjᐟ³	məːjᐟ³	məːjᐟ³	məːjᐟ³		
180	talon, heel	**-kɔːc	ɣɔtᴰ¹													dɔndɔːn	kdəːl	dʌldʌːl	*kdəːlᐟ³	dəːlᐟ³		kɔːcˀ⁷	kɔːcˀ⁷	kɔːcˀ⁷		k-ɗəːlʔ
181	vinaigre, vinegar	*-jəmʔ	zəmᴮ¹	zəmᴮ¹	zəmᴮ¹	zəmᴮ¹														jʌmᐟ³	jʌmᐟ³	jəmᐟ³	jəmᐟ³	jəmᐟ³		
182	dur, hard	*kəŋʔ	kɨŋᴮ¹	kɨŋᴮ¹	kɨŋᴮ¹	kɨŋᴮ¹										kɔŋ		kʌŋ	*kɨŋᐟ³		kɨŋᐟ³			kʌŋᐟ³		
183	vouloir, désirer, to wish, desire	*ɓəːlʔ	muənᴮ¹	munᴮ¹	muənᴮ¹	ʔɨŋᴬ¹										baən		bʌːl	*bəːlᐟ³	bɨənᐟ³	buonᐟ³					

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184	combien, how many	*bəlʔ	məj^{B1}													bɔn	bil	bʌl	*bil^{3}	bʌj^{3} et	bʌj^{3}					
185	matin, morning	*k-rəːmʔ	səːm^{B1}					tarəːk^{7}	tarʌːk	caɣəːk^{7}			ʂəːm^{3} / srəːm^{3}	ʂəːm^{3}	arʌːmʔ	kʰlaəm	kʰləːm	kʰlaəm	*kʰrəːm^{3}	kʰrəːm^{3}	ʂəːm^{3}	kʰəːm^{3}	kʰəːm^{3}	kʰəːm^{3} /kʰəːm^{3}	kʰəːm^{3}	*t-rəːk
186	oeuf, egg	*k-ləːŋʔ	tɕɨŋ^{B1}	tɕəŋ^{B1}	tɕəːŋ^{B1}	tɨŋ^{B1}	tɕəŋ^{A1}	taruːl^{3}	tulʊːrʔ	tuluːɯ^{3}	tulun^{3}	tulul^{3}	tuluːl^{3}	tuluːl^{3}	ulʊːlʔ	klaəŋ	kləːŋ	klaəŋ	*kləːŋ^{3}	kləːŋ^{3}	ʈʌŋ^{3}	tləːŋ^{3}	kləŋ^{3}	kləŋ^{3}	kləŋ^{3}	*t-luːrʔ
187	se souvenir, to remember	*k-ɲəːʔ	ɲə^{B1}					ɲəː^{3}		kəɲəː^{3}			kəɲəː^{3}	ɲəː^{3}	ɲʌːʔ	ɲaə	kʰɲəː	ɲae	*kɲəː^{3}	ɲəː^{3}	ɲəː^{3}		ɲəː^{3}	ɲəː^{3}	ɲəː^{3}	
188	tonnerre, thunder	*k-rəmʔ	səm^{B1}	səm^{B1}	səm^{B1}	səm^{B1}		ʃɨm^{3}	kɨrɨmʔ				kʰlɨm^{4}	ʈɨm^{4}	kərɨmʔ	kɔn	kil	kʌl	*kil^{2}	kʰrʌm^{4}	ʂəm^{4}	kʰəm^{3}	kʰəm^{3}	kʰəm^{3}	kʰəm^{3}	*gər
189	pouls, pulse	*-nəmʔ	nəm^{A1}																*nɨm^{3}							
190	tendre (la main), lever, tighten (by hand), lift	*k-jəː	zə^{A1}					sajəː^{1}			cadɔːj^{3}			cɔh^{1}		jaə	kăjəː		*kjəː^{1}	jəː^{1}		jəː^{1}	jəː^{1}	klɔː^{5}		
191	faire que, to that	*cəː	tɕɔ^{A1}													caə		cae	*cəː^{1}	cəː^{1}	cəː^{1}					
192	avant, before	*g-rəː	sə^{A1}													kʰlʌə	kʰləː	kʰləː	*kʰrəː^{2}	kʰrəː^{2}	ʂəː^{2}					
193	champignon, mushroom	*ɗəm	nəm^{B1}					bɔːc^{7}	bɒːc^{7}	kàa^{2}		bɔːc^{7}	ʈàa^{2}	ʈàa^{2}	trìə		ktat		*ktat^{7}	dəm^{3}	dəm^{3}	ceːl^{3}	ceːə^{3}	ceːl^{3} | tat^{7}	ceːn^{3}	*ɓɔːc
194	riz cuit, cooked rice	*kəːm	kəːm^{A1}										kəːm^{1}	kəːm^{1}	kəːm^{1}	kəːm	kəːm	kəːm	*kəːm^{2}	kəːm^{2}	ɣəːm^{2}		kəːm^{1}	kəːm^{1}	kəːm^{1}	
195	voler, to fly	*pər	ɓaj^{A1}					pel^{1}	pər	pəɯ^{1}	hun^{3}		pəl^{1}	pəl^{1}	pal	pɔn	pil	pʌl	*pil^{1}	pʌl^{1}	pʌn^{1}	pal^{1}	paə^{1}	pal^{1}	ban^{1}	
196	arbre, tree	*kəl	kəj^{A1}	kən^{A1}	kəːn^{A1}	kəj^{A1}	kəːn^{A1}	kəl		kəj^{1}			kəj^{2}	kəj^{1}		kɔn	kaw	kʌl	*kil^{2}	kʌl^{2} / ɣʌj^{1}		kəl^{1}	kaə^{1}	kəl^{1}	kən^{1}	*gawʔ
197	estoquer, frapper de la pointe, xxx, hit with the tip	*təm	ɗəm^{A1}													tɔm^{1}	tɨm^{2}	tɔm^{1}	*tɨm^{1} / tɨm^{2}	tʌm^{2}	ɓʌm^{1}					
198	odorant, fragrant	*tʰəːm	tʰəːm^{A1}													tʰaəm		tʰaəm	*tʰəːm^{1}	tʰəːm^{1}	tʰəːm^{1}					
199	plateau, tray	*ɓəm	məm^{A1}													bɔm	bɨm	bɔm	*bɨm^{1}	bʌm^{1}	bʌm^{1}					
200	tatouer, piquer de petits trous, tattoo, poke small holes	*tʃəm	səm^{A1}	tɕɔːk^{D2}	tɕak^{D2}	tɕɔk^{D2}																				
201	python, python	*k-lən	tɕan^{A1}					kalan^{1}		lan^{4}	talɛn^{1}	talɛn^{1}	lèn^{4}	lèn^{2}	ulan	klɔn	klin	klʌn	*klin^{1}	klaɲ^{2}		tlan^{1}	kan^{1}	klan^{1}	ʈan^{1}	
202	Année, year	*c-nəm	nam^{A1}					sənam^{1}	sənam^{1}	nam^{1}	cɔm^{1}	cɔm^{1}	nam^{1}	nam^{1}		cɔm	cɨm	cɔm	*cɨm^{1}	nam^{1}	nʌm^{1}	nam^{1}	nam^{1}	nam^{1}	nam^{1}	
203	dos, back	*k-ləŋ	lɨŋ^{A1}										nuːl^{4}	nuːl^{4}		lɔŋ	kʰlɨŋ	lʌŋ	*kʰrɨŋ^{1}	kʰrɔːŋ^{3}	lʌŋ^{1}		lɨŋ^{1}	ləŋ^{1}		*nuːlʔ
204	nuage, cloud	*k-məl	məj^{A1}										məl^{1}	məl^{1}		mun	kmil	mʌl	*kmil^{1}	mʌl^{1}	mʌn^{1}	məl^{2}	maə^{1}	məl^{1}	mən^{1}	
205	arbre à laque, black varnish tree	*k-rəːn	səːn^{A1}																	kʰrəːn^{1}	ʂəːn^{1}		kʰəːn^{1}			
206	rotin, rattan	*-məl	məj^{A1}	məj^{A1}	məj^{A1}	məj^{A1}										sac	ksɛk	sac	*ksac^{7}	meː^{2}	meː^{2}		maə^{1}	məl^{1}		*-meː
207	écorchure, a scratch	*b-ləːl	tɕəj^{A1}													pləːn		pləːl	*pləːl^{2}		ʂʌj^{2}					
208	argent, silver	*ŋən	ŋən^{A1}														ŋin	ŋʌn	*ŋin^{2}							
209	couver, to lay eggs	*ʔəp	ʔəp^{D1}					karəm^{1}	karʌm		kaləm^{1}	kaləm^{1}	karəm^{1}	karəm^{1}	anam	ʔɔp	ʔɨp	ʔɔp	*ʔɨp^{7}	ʔʌp^{7}	ʔʌp^{7}	ʔəp^{7}	ʔəp^{7}	ʔəp^{7}		*k-rəm
210	éclair, lightning	*k-cəːp	tɕəːp^{D1}							cəːp^{7}	acòɔp^{8}		cəːp^{7}	cəːp^{7}	cʌːp^{7}	cəːp	kcəːp	cəːp	*kcəːp^{8}	cəːp^{7}	cəːp^{7}		cəːp^{7}	cəːp^{7}	cəːp^{7}	
211	éteindre, to put out (a fire)	*p-sət	tat^{D1}							məsat^{7}	pəsèt^{8}		pəsat^{7}	pəsat^{7}	atʰat	sɔt	psit	sʌt	*sit^{7}	sʌt^{7}	sat^{7}		tʰat^{1}	sat^{1}	sat^{1}	
212	plier, to fold	*p-kəp	ɣəp^{D1}							təkəp^{7}			pəkəp^{7}	pəkəp^{7}						kap^{8}					kəp^{7}	
213	se couvrir (d'une couverture), to cover (w. a blanket)	*səp	ɗap^{D1}							sip^{7}	sɔp^{7}	sɔp^{7} / sup^{7}	sʌp^{7}	sap^{7}		sɔp	sɨp	sɔp	*sɨp^{7}	sʌp^{7}	sap^{7}					
214	terre, earth	*tət	ɗət^{D1}													tɔt	tit	tʌt	*tit^{7}	tʌt^{7}	tʌt^{7}		tʌt^{7}	tʌt^{7}	dʌt^{7}	
215	heurter, to bump	*pəp	vəp^{D1}	ɓəp^{D1}	ŋo^{A1}	ɓəp^{D1}										pɔp			*pɨp^{7}		vʌp^{7}					
216	perdre, to lose	*ɓət	mət^{D1}													bɔt		bʌt	*bit^{7}	bʌt^{7}						
217	piment, chili	*ʔəːt	ʔəːt^{D1}													ʔaət	cŋaːj	ʔaət	*ʔəːt^{7}	ʔəːt						*c-ŋaːj

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218	se lever, se réveiller, to get up, awaken	*k-sək	$t^hɨk^{D1}$													sɔk	ksɨk	sʌk	*ksɨk⁷	sɨk⁷	sɨk⁷					
219	soulever, lever, to lift, raise	*kət	$kət^{D1}$														kit	kʌt	*kit⁷							
220	jeter, to throw	*-vət	$vət^{D1}$	$vɨt^{D1}$	$kʷæŋ^{A1}$	$kʷaŋ^{A1}$	$vɨt^{D1}$									vit	vit	vet (vi)	*vit⁷							
221	fort, strong	*k-rək	$sɨk^{D1}$	$sɨk^{D1}$	$sɨk^{D1}$	$tʰɨk^{D1}$							$kʰrɨk^7$	kătəːŋ³	ʃək				*$kʰrɨk^7$			$kʰək^7$				
222	couvercle, a lid	*k-rəp	nap^{D1}													$kʰlɔp$	$kʰlɨp$		*$kʰrɨp^7$							
223	couverture, blanket	*s-nəp	nap^{D1}													nɔp		nɔp	*$snɨp^7$							
224	tomber (un objet), to drop (an object)	*-rəːc	$zəːt^{D1}$													ɣaəc		ʰlaəc	*$rəːc^7$							
225	sale, dirty	*-ɲəːp	$ɲəːp^{D1}$															ɲaəp	*-$ɲəːp^7$	$ɲəːp^7$						
226	gratter (poule - le sol), scratch (chicken - soil)	*kəs	$zaːj^{c2}$					keːl⁵	kʌr	kəɯʰ																
227	graisse, fat	*məh	$mə^{c2}$				$mə^{B2}$						$kluŋ^2$	$tluŋ^2$	tlùŋ					mə:⁶	mə:⁵⁶	mə:⁴⁶	mə:⁶	mə:⁴⁶	mmə:⁴⁶	*k-luŋ
228	ciel, sky	*b-ləːj	$tɕəːj^{A2}$										$pləːj^2$	$pləːj^2$	$tləːj^1$	pləːj	pləːj	pləːj	*$pləːj^2$	$bləːj^1$	ʐɨəj²	$tləːj^2$	$pləːj^2$	$bləːj^2$	ʈəːj²	
229	dette, debt	*b-n-əːʔ	$nə^{B2}$										pənɨː⁴	pənɨː⁴	nɨːʔ	nʌə		mləː	*mləː⁴	nəː⁴	nəː⁴					
230	se fâcher, to get angry	*ɟənʔ	$zən^{B2}$	$ɓəːt^{D1}$	zan^{B2}	$ɓaːj^{B2}$										cɔn		cʌn	*cin⁴	cʌn⁴	ðʌn⁴					
231	accepter en prêt, accept a loan	*bəːʔ	$ɓə^{B2}$																							
232	pou de corps, body louse	*m-rəɲʔ	$zən^{B2}$	$zən^{B2}$	zan^{B2}	$zən^{B2}$	$tɕən^{A1}$	$bəriɲ^3$	$barìɲ^4$	$nɣiɲ^3$	ahiŋ³	$məhiŋ^3$	$briɲ^3$	$briɲ^3$	nriɲʔ/ntʃíɲʔ	$pʰlʌɲ$	$pʰliŋ$	$pʰlɛɲ$	*$pʰriɲ^3$	$pʰriɲ^3$	siɲ³		$kʰiɲ^3$	$fəɲ^{46}$		
233	cheval, horse	*m-ŋəːʔ	$ŋɨə^{B2}$					$maŋəː^3$	$maŋʌː^3$	ŋɨa⁴	maː⁴	meː⁴	ŋɨa⁴	ŋɨa⁴		ŋɨa⁴				ŋɨa⁴	ŋɨa⁴	ŋɨa⁴⁶	ŋɨa⁴	ŋɨa⁴⁶	ŋɨa⁴	
234	fil, thread	*k-rəːjʔ	$sə:j^{B2}$																	$kʰrəːj^4$	ʂəːj⁴	$kʰɨəj^{46}$	$kʰəːj^4$	$kʰɨəj^{46}$		
235	près, near	*t-kəɲ	$ɣən^{A2}$	$ɣən^{A2}$	$ɣɨn^{A1}$	$ɣən^{A2}$	$ɣɨn^{A1}$						təkiɲ¹	təkiɲ¹									$kʰəɲ^1$	$kʰəɲ^1$	$kʰəɲ^1$	*s-ɗəː
236	affûter, to grind	*k-ɓən	$maːj^{A2}$													bɔn	kbin	bʌn	*kbin⁷							
237	gingembre, ginger	*s-gəːŋ	$ɣɨŋ^{A2}$	$ɣəŋ^{A2}$	$ɣəŋ^{A2}$	$ɣəŋ^{A2}$	$ɣəŋ^{A2}$	$səkɨŋ^2$	sakàŋ	$ŋkɨŋ^2$	cəkoɔ̀ŋ²	$sakɛːŋ^2$	apuːj¹	apuːj¹	trɛh	kəːŋ	tkəːŋ	kəːŋ	*təkəːŋ₂	kəːŋ²	ɣɨŋ²	kəːŋ¹	kəːŋ¹	kəːŋ¹	kəːŋ¹	
238	lit, bed	*k-ɟəːŋ	$zɨəŋ^{A2}$					$kəcɨːŋ^2$	kacɨəŋ	$kəcɨːŋ^2$			$kəcɨːŋ^2$	$kəcɨːŋ^2$					*kəcəːŋ₂	cəːŋ²	jɨaŋ²		cɨəŋ²	cɨəŋ²	cɨəŋ²	
239	corne, horn	*k-rəŋ	$sɨŋ^{A2}$	$səŋ^{A2}$	$səŋ^{A2}$	$tʰɨŋ^{A2}$	$tɕɨŋ^{A2}$	$təkɔːj^1$	təkɒːj	$təkɔːj^1$	$təkɔːj^1$	$təkɔːj^1$	$kʰləŋ^2$	ʈəŋ²	(takɛː)	$kʰlɔŋ$	$kʰlɨŋ$	klʌŋ	*$kʰrɨŋ^2$	$kʰrɨŋ^2$	ʂɨŋ²	$kʰəŋ^2$	$kʰɨŋ^2$	$kʰəŋ^2$	$kʰɨŋ^2$	*t-kɔːj
240	gencives, gums	*ləɲ	$lə:j^{B2}$					liːŋ²					liɲ²	liɲ²	(hɪc)	lɔn	lin-	lʌn	*lin²							
241	travailler, to work	*mən	$mən^{A2}$													mɔn	min	mʌn	*min²	mʌn²	mʌn²		la:²	la:²		*la:
242	content, happy	*məːŋ	$mɨŋ^{A2}$	$məŋ^{A2}$	$məŋ^{A2}$	$mɨŋ^{A2}$													*$məːŋ^2$							
243	mâle, male	*dək	$ɗɨk^{D2}$					koːɲ³	koːɲ³		kuːɲ³	kuːɲ³	$tɨk^8$	$tək^8$		tɔk			*$tɨk^8$		$dɨk^8$	$tək^8$	$tək^8$	$tək^8$	$dɨk^8$	
244	battre le riz, décortiquer, to thresh rice, to husk rice	*dəp	$ɗəp^{D2}$													tɔp		tɔp		pɒː⁵			təp⁸	təp⁸	dəp⁸	
245	fiel, gall	*məc	$mət^{D2}$	$mət^{D2}$	mat^{D2}	$mət^{D2}$		met^8	mɨt	$mət^8$	mit^8	mit^8	$mɨt^8$	$mɨt^8$	mɨt	mɔt	mik	mʌt	*mic^8	mic^8 / mik^8		$mət^8$	$mət^8$	$mət^8$	$məc^8$	
246	ramasser, glaner, to collect, gather	*m-ləc	$ɲat^{D2}$												alɪc											
247	poitrine, chest	*ŋək	$ŋɨk^{D2}$					$kacəː^{56}$	kacʌːʔ	kacəh¹						ŋɔk			*$ŋɨk^8$		$ŋɨk^8$		$ŋək^8$	$ŋək^8$		*k-cəh
248	miel, mélasse, honey, molasses	*məc	$mət^{D2}$							leŋ⁴						mʌc	mik	mɛc	*mic^8	mic^8 / mik^8	mec^8		$məc^8$	$məc^8$	$məc^8$	

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	VOWEL *oː																									
249	poumons, lungs	*p-soːs	foj^{c1}				foj^{c1}	soː^{5}	jǫːʔ	soːɯ^{h1}	suh^{1}	suh^{1}	soh	soh	tʰòh	pʰaoj	pʰoːt		*pʰoːc^{7}	pʰɔːl^{5}	foːn^{56}	poːc^{5}	poːj^{5}	poːc^{1}	foːj^{5}	
250	verser, to pour	*toh	ɗoc^{c1}					toː^{5}	tɤːʔ	toh^{1}			toh^{1}	toh^{1}	tòh	tɔk	tuk		*tuk^{7}	joː^{6}	jua^{56}	toː^{5}	toː^{5}	toː^{5}		
251	goyave, guava	*k-ʔoːs	ʔoj^{c1}					ʔoːj^{56}					kăʔoːl^{4}	kăʔoːl^{4}		ʔaoj			*ʔoːj^{3}	ʔɔːj^{5}	ʔoːj^{56}		ʔoːj^{5}	ʔoːj^{5}		
252	arracher, désherber, to pull, to weed	*ʃoh	ɲoc^{c1}					ʐoː^{56}						ɟoː^{4}						dɔː^{5}	ʔδoː^{56}	joː^{5}	joː^{5}	joː^{5}		
253	éclater, to explode	*ɗoh	noc^{c1}																	dɔː^{5}		doː^{5}	roː^{5}	doː^{5}		
254	flotter sur l'eau, to float on water	*ɗoːs	nojc^{c1}													daoc			*doːc^{7}	dɔːl^{5}		noːj^{5}	noːj^{5}			
255	honte, shame	*ʔoh	hoc^{c1}													ʔaw		ʔaw	*ʔoː^{3}							
256	ouvrir (le ventre), inciser, open (the belly), incise	*ɓoh	moc^{c1}																*boː^{3}		boː^{56}					
257	sortir, to go out	*ʔa-loh	loc^{c1}					loː^{5}		luh^{1}	luh^{1}		loh^{1}	luh^{1}	alòh	saː	saː	saː	*saː^{1}	saː^{1}	ʂaː^{1}	tʰaː^{1}	tʰaː^{1}	saː^{1}		*-saː
258	fleurir, to blossom	*m-loh	loc^{c1}							məloh^{2}			bloh^{1}	bloh^{1}						blɔː^{5}	loː^{56}		coː^{5}	bloː^{5}	ʈo^{6}	
259	panier, basket	*-roh	zoc^{c1}																	rɔː^{5}	ʂoː^{56}		ʐoː^{5}	tʰoː^{5}		
260	nourrir > adopté, to feed > to adopt	*ɗoːj	nuəj^{A1}											ciɛm^{4}						doː^{j1}	duoj^{1}	ciɛm^{3}		ciɛm^{3}		*ɟɛːmʔ
261	malodorant, bad-smelling	*hoːj	hoj^{A1}													haoj	hoːj	hoːj	*hoː^{j1}	hɔː^{j1}	hoː^{j1}	hoː^{j1}				
262	paire, jumeaux, pair, twins	*toːj	ɗoj^{A1}															toːj	*toː^{j1}	tɔː^{j1}	toː^{j1}	toː^{j1}	toː^{j1}	toː^{j1}		
263	couler, s'écouler, emporté par le courant, flow, flowing, swept away by the current	*c-loːj	tɕoj^{A1}								salo:j^{1}	salo:j^{1}				klaoj	kloːj	kloːj	*kloː^{j1}			tloː^{j1}				
264	appui-tête, coussin, head-cushion, cushion	*k-ɗoːlʔ	ɣoj^{B1}										kadoː^{l3}	kudoː^{l3}	akuəlʔ					kɔː^{l3}	ɣoː^{j3}	keː^{l2}	keːə^{2}	keː^{l2}	keːn^{2}	*-koːlʔ
265	lézard, lizard	*ɓoːlʔ	moj^{B1}					kanaː^{l1}	təlòɔ	təluɔ^{2}	kanaːn^{1}	kanaːn^{1}	kanèal^{2}	kanèal^{2}	nìəl	bɔnbaon	bolboːl	bɔlbɔːl	*boː^{l3}	bɔː^{l3}	moː^{j3}		moːə^{3}			*t-lɔː
266	père, father	*poːʔ	ɓo^{B1}	ɓo^{B1}	niw^{B1}	tɕa^{A1}	ɓɔ^{B2}	pɨː^{3}	pɘː^{3}	pɨː^{3}	ʔɔŋ^{1}	ʔɔŋ^{1}	pɨ̀ː^{4}	bɔː^{4}	pìəʔ				*ʔiː^{1}	teː^{4}	bɔː^{4}	poː^{3}	ʔɛːŋ^{1}	poː^{3}	boː^{3}	
267	quatre, four	*poːnʔ	ɓon^{B1}					poːn^{3}	pɒːnʔ	poːn^{3}	poːn^{3}	poːn^{3}	poːn^{3}		puənʔ	poːn	poːn	poːn	*poːn^{3}	pɔːn^{3}	poːn^{3}	poːn^{3}	poːn^{3}	poːn^{3}	boːn^{3}	
268	sauterelle, grasshopper	*coːʔ	tɕəw^{B1}	tɕəw^{B1}	tɕəw^{B1}	tɕəw^{B1}		ɲɔːj^{56}	ɲɒːjʔ		ɲɔjʰ	ɲɔh	cucùː^{4}	cucùː^{4}	uɟun				*bok ba:j^{1}	cow^{1} cow^{3}		coː^{3} coː^{3}	coː^{1} coː^{3}	kɔːn^{1} coː^{3}	coː^{1} coː^{3}	*-ɲɔːs
269	joindre, attacher deux cordes, to attach, to tie two ropes	*ɗoːlʔ	noj^{B1}							doː^{l3}			doː^{l3}	doː^{l3}		daɔn		dɔːl	*doː^{l3}							
270	mortier à riz, rice mortar	*t-koːlʔ	koj^{B1}					təkoː^{l3}	tăkǫːlʔ	təkoː^{l3}	koː^{l3}		təkoː^{l3}	təkoː^{l3}		kaon		kɔːl	*tkoː^{l3}	kɔː^{l3}	koːj^{3}	koː^{l3}	koːə^{3}	koː^{l3}	koːn^{3}	
271	pagne, langouti|loin-cloth	*kʰoːʔ	xo^{B1}					satɔːj^{3}	srtɒːjʔ	ntɔːj^{3}			cntɔːj^{3}	catɔːj^{3}					*-	kʰɔː^{3}	kʰoː^{3}		kʰoː^{3}	kʰoː^{3}		*sr-tɔːjʔ
272	semence, seed	*k-coːŋʔ	zoŋ^{B1}							kəcoːŋ^{3}			kəcoːŋ^{3}	kəcoːŋ^{3}		caoŋ		cɔːŋ	*kcoːŋ^{3}		coːŋ^{3}	coːŋ^{3}	joːŋ^{3}			
273	traces, empreinte, trace, footprint	*k-toːʔ	zəw^{B1}	zəw^{B1}	zəw^{B1}	zəw^{B1}							kataw^{3}	kataw^{3}					*seːk	jɔːk^{8}	ðʌw^{3}	toː^{3}	toː^{3}	toː^{3}		
274	tube, tuyau, tube, pipe	*ʔoːŋʔ	ʔoŋ^{B1}								ʔoːŋ^{3}			ʔoːŋ^{3}		ʔaoŋ	ʔoːŋ		*ʔoːŋ^{3}	ʔɔːŋ^{3}	ʔoːŋ^{3}		ʔoːŋ^{3}	ʔoːŋ^{3}		

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275	cuire (à l'eau), cuisiner, to boil water, to cook	*ɗoːʔ	nəwᴮ¹	nəwᴮ¹	nəwᴮ¹	nəwᴮ¹						ădɔː								dɔːˀ³	doːˀ³	noːˀ³	noːˀ³	noːˀ³	noːˀ³	
276	végétal, végétation, plant, vegetation	*koːjʔ	kojᴮ¹																	koːj³	koːj³		koːj³	koːj³	koːj³	
277	âpre, bitter	*coːʔ	tɕuəᴬ¹													caw	coː	caw	*coːˀ³	cɔːˀ³						
278	arroser, to sprinkle	*soːjʔ	sojᴮ¹													saoj	soːj		*soːj³							
279	s'appuyer sur un bâton, to lean on a stick	*coːŋʔ	tɕoŋᴮ¹													caoŋ			*coːŋ³	cɔːŋ³						
280	fuir, s'enfuir, se cacher|to flee, hide	*k-loːnʔ	tɕonᴮ¹					kəloːn³		kəloːn³			klɔːn³	tlɔːn³	tluənʔ					klɔːn³	ʈoːn³					
281	termite, termite	*k-moːlʔ	mojᴮ¹	monᴮ¹	mojᴮ¹	mojᴮ¹		kəmuːl³	kəmʊːrʔ	kəmuːɯ³	kəmɔːl³	kamɔːl³	kəmùːl⁴	kəmùːl⁴	umùəlʔ	mɔnma mɔnmɔːn	kʰamoːl | kʰmoːl	mɔlmɔːl mɔːl	*kmoːl³	mɔːl³	moːn³		moːəˀ³	moːl³	moːn³	*k-muːrʔ
282	vivant, cru, alive, raw	*k-roːŋʔ	soŋᴮ¹					silɔːŋ³		ciɭɔːŋ³			klɔːŋ³	tluoŋ⁴	tloŋʔ	kʰloːŋ	kʰloːŋ	kʰloːŋ	*kʰroːŋ₄	klɔːŋ⁴			kʰoːŋ³	kʰoːŋ³	kʰoːŋ³	
283	dos, arête, back, ridge	*k-roːŋʔ	soŋᴮ¹					səɾɔːŋ³	rɔŋʔ	kuɣɔːŋ³			kʰloːŋ³ / nuːl⁴				kʰloːŋ	kʰlɔːŋ	*kʰroːŋ₃	kʰrɔːŋ³	ʂoːŋ³		roːŋ³	doːŋ³	roːŋ³	
284	rêver, to dream	*s-poː	ɓaːwᴬ¹					səpoː¹		təpoː²	apoː¹		cəpoː¹	cəpoː¹	mpɔː	pɔː	kpoː	paw	*kəpoː¹				paw¹	paw¹	baw¹	
285	mûre, blackberry	*-toː	zəwᴬ¹	ɗəwᴬ¹	zəwᴬ¹	zəwᴬ¹														tɔː¹	ɓaw¹	toː¹	toː¹	toː¹		
286	épis (de riz), ear (of rice)	*k-joː	zɛᴮ¹													joː²	kəjoː¹	joː²	*kjoː	soː²						
287	sec, dry	*kʰoː	xoᴬ¹													kʰaw			*kʰoː¹	kʰɔː¹	kʰoː¹					
288	brassée, armful	*ʔoːm	ʔomᴬ¹									kavɛkˀ⁸	ʔoːm¹	ʔoːm¹		ʔaom		ʔaom	*ʔoːm¹	ʔɔːm¹	ʔoːm¹		ʔoːm¹	ʔoːm¹		
289	fleur, flower	*poːŋ	ɓoŋᴬ¹					poːŋ¹	poːʔŋ | pǫːŋ	pəal²	poːŋ¹	poːŋ¹	pəal²	pəal²		paoŋ	poːŋ	pɔːŋ	*poːŋ¹	pɔːŋ¹	poːŋ¹	poːŋ¹	poːŋ¹	poːŋ¹		*baːr
290	écrevisse, crevette, crayfish, shrimp	*soːm	tomᴬ¹					soːm¹	soːm	toːm¹										soːm²	soːm²	tʰoːm¹	tʰxːm¹	soːm¹	soːm¹	
291	taro, tubercule, taro, tuber	*ɓoːn	monᴬ¹					bɔːn¹		boːn						bɔːn	boːn	bɔːn	*boːn¹	bɔːn¹	moːn¹		voːn¹	boːn¹	NA	
292	paon, peacock	*k-voːŋ	koŋᴬ¹				kuəŋᴬ¹	kəvoːŋ¹	kəvoːŋ¹	kuoŋ¹	kəvɔːŋ¹		kəvoːŋ¹	kəvoːŋ¹					*kəvoːŋ₁	kuoŋ¹	koːŋ¹	koːŋ¹	koːŋ¹	koːŋ¹		
293	fesses, buttocks	*t-moːŋ	moŋᴬ¹											təmoːŋ¹ tùːl⁴												
294	fleuve, river	*k-roːŋ	soŋᴬ¹						hɔːŋʔ							kʰlɔːŋ	kʰlɔːŋ	kʰlɔːŋ	*kʰrɔːŋ¹	kʰrɔŋ¹	ʂɔːŋ¹	kʰoːŋ¹	kʰoːŋ¹	kʰoːŋ¹	kʰoːŋ¹	*k-rɔːŋ
295	plume, poil, cil, feather, hair, fur	*-loːŋ	loŋᴬ¹																	lɔːŋ¹	loːŋ¹	loːŋ¹	loːŋ¹	loːŋ¹	loːŋ¹	
296	escargot, snail	*ʔoːk	ʔokᴰ¹					kacoːˀ⁵⁶	kacʊːʔ	pacuhˀ¹			ʔoːkˀ⁷	ʔoːkˀ⁷	tlɑːʔ					ʔɔːkˀ⁷	ʔowkˀ⁷		ʔoːkˀ⁷	ʔoːkˀ⁷		*k-cuh
297	souche, stump	*t-koːk	ɣokᴰ¹				koːkᴰ¹	təkoːkˀ⁷		koːkˀ⁷	təkokˀ⁷	təkokˀ⁷	təkoːkˀ⁷	təkoːkˀ⁷	təkoːk	kokkoːk	tkoːk	kokkoːk	*tkoːkˀ⁸	koːkˀ⁸		koːkˀ⁷	koːkˀ⁷	koːkˀ⁷	koːkˀ⁷	
298	poignée, contenant de 2 mains réunies, handful, contents of two cupped hands	*poːk	vokᴰ¹					kaboːkˀ⁷	pɔkˀ⁷	boːkˀ⁷	kʰadoːmˀ¹	kadoːmˀ¹	poːkˀ⁷	poːkˀ⁷			kpoːk		*kpoːkˀ⁷	pɔːkˀ⁷	poːkˀ⁷		poːkˀ⁷	boːkˀ⁷ | doːmˀ¹		*k-ɗoːm
299	cuir, peau, leather, skin	*k-roːt	lotᴰ¹					kəroːtˀ⁷	kʰloːtˀ⁷	kəɣoːtˀ⁷	kʰəloːtˀ⁷	kʰəloːtˀ⁷	kəroːtˀ⁷	kəroːtˀ⁷	aruət	kʰlaot	kʰloːt	kʰlaot	*kʰroːtˀ⁷	kʰrɔːtˀ⁷						
300	un, one	*moːc	motᴰ²	motᴰ²	mɔtᴰ²	motᴰ²		moːcˀ⁸		muːcˀ⁸	muːtˀ⁸		mʊːcˀ⁸	mʊːcˀ⁸	mùːc	moːc	moːt	muːc	*moːcˀ⁸	moːtˀ⁸	moːtˀ⁸		moːtˀ⁸	moːcˀ⁸	moːtˀ⁸	
301	riz décortiqué, husked rice	*r-koːʔ	ɣaːwᴮ²	kəwᴮ¹	ɣɤwᴮ²	ɣaːwᴮ²	kəwᴮ¹			ŋkɔwˀ³	akoːˀ³		təkoːˀ³	təkoːˀ³	ŋkɔːʔ	kaw	koː	kaw	*koːˀ³	kɔːˀ³	ɣawˀ⁴	kaːwˀ³	kaːwˀ⁴	kaːwˀ³	kaːwˀ³	

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302	porter (un chapeau), to wear (a hat)	*doːjʔ	ɗojᴮ²							doːjˀ⁴									*kduː³	cɛː²	doːjˀ⁴	toːj⁴⁶	toːj⁴	puoŋ¹	doːj⁴⁶	
303	ventre, belly	*p-loːŋʔ	ɓuŋᴮ²						rɒːc			kaʔaːlˀ¹	kŭdʌlˀ¹				kluŋ		*kluŋ⁴	duːlˀ³		tloːŋ⁴⁶	kloːŋ⁴	ploːŋ⁴⁶	ʈoːŋ⁴⁶	
304	large, wide	*roːŋʔ	zoŋᴮ²													ɣoːŋ		ʰloːŋ	*roːŋ⁴	roːŋ⁴	ʐɔːŋ¹		ʐoːŋ⁴	tʰoːŋ⁴⁶		
305	tombeau, grave	*g-roʔ	moᴮ²														kʰloː	kʰloː	*kʰroː⁴							
306	taro, taro	*s-roːʔ	sɔᴮ²								tʰoː³	saloː³								sɔː⁴	ʂɔː⁴					
307	cuire à la vapeur, to steam rice	*doː	ɗoᴬ²					taho:t⁷	tahǫ:t		taho:t⁷	taho:t⁷	taho:t⁷	taho:t⁷		saoj		so:j	*so:j¹			to:²	to:²	to:²	do:²	*so:j
308	belette, weasel	*ɟoːn	tɕonᴬ²								tamuːŋ¹	tamuaŋ¹	aroːŋ¹							coːn²	juon²					
309	mari, husband	*ɟoːŋ	tɕoŋᴬ²						kʊːɲʔ		pacoŋ¹	pacoŋ¹	makuːɲ³						*ʔoːŋ¹	jɔːŋ¹	juaŋ¹ (˂ɟoːŋ)	coːŋ²	ʔoːŋ¹			
310	cuivre, copper	*doːŋ	ɗoŋᴬ²													toːŋ	toːŋ	toːŋ	*toːŋ²	toːŋ²	ðuoŋ²		toːŋ²	toːŋ²	toːŋ²	
311	planter (un arbre), to plant (a tree)	*m-loːŋ	tɕoŋᴬ²				loŋᴬ¹			məloːŋ¹			pəloːŋ¹			blaoŋ	bloːŋ	blɔːŋ	*bloːŋ¹	blɔːŋ¹	loːŋ¹	tloːŋ¹	loːŋ¹	bloːŋ¹	ʈoːŋ¹	
312	dragon, dragon	*-roːŋ	zoŋᴬ²					səmɨlˀ¹	səmɨrˀ¹		məhiːŋ²					kʰlow	kʰluː	kʰlow	*kʰruː⁴	ʐoŋ²	ʐoŋ²	roːŋ²	rɔŋ²	tʰoːŋ²	ʐoːŋ²	*s-mɨr
313	marmite à riz, cooking pot	*noːl	nojᴬ²																			no:l²	no:ə²	no:l²	no:j²	
314	caroncule > crête (dial.), caruncle> peak (dial.)	*moːŋ	moŋᴬ²																	moːŋ²	moːŋ²					
315	carapace (crabe, tortue), shell (crab, tortoise)	*goːp	ɣopᴰ²										koːpˀ⁸	koːpˀ⁸	kòːp					kɔːpˀ⁷						
316	piloti, poteau, xxx, post	*goːt	kotᴰ²					tajuːlˀ¹	tajʊːr		pacuːˀ¹		katəlˀ¹	koːtˀ⁸		koːt		koːt	*koːtˀ⁸	koːtˀ⁸	ɣuotˀ⁸	koːtˀ⁸	koːtˀ⁸	koːtˀ⁸	koːtˀ⁸	*t-juːr
317	poison, vénéneux, poison, poisonous	*doːk	ɗokᴰ²																	toːkˀ⁸	doːkˀ⁸	toːkˀ⁸				
318	poumons, lungs	*p-soːs	fojᶜ¹				fojᶜ¹	soːˀ⁵	jǫːʔ	soːɯʰ¹	suhˀ¹	suhˀ¹	soh	soh	tʰòh	pʰaoj	pʰoːt		*pʰoːcˀ⁷	pʰɔːlˀ⁵	foːnˀ⁵⁶	poːcˀ⁵	poːjˀ⁵	poːcˀ¹	foːjˀ⁵	
319	verser, to pour	*toh	ɗoᶜ¹					toːˀ⁵	tʊːʔ	tohˀ¹			tohˀ¹	tohˀ¹	tòh	tɔk	tuk		*tukˀ⁷	joːˀ⁶	juaˀ⁵⁶	toːˀ⁵	toːˀ⁵	toːˀ⁵		
	VOWEL *ɛː																									
320	casser en deux, cueillir, to break in two, to pick	*pɛh	ɓɛᶜ¹								pɛhˀ¹				pɛh	pɛː	pɛː	pɛː	*pɛːˀ³	pɛːˀ⁵	pɛːˀ⁵⁶	pɛːˀ⁵	peːˀ⁵	pɛːˀ⁵	bɛːˀ⁵	
321	débiter des liens, cut connections	*cɛh	tɕɛᶜ¹					cɛːˀ⁵⁶		cɛhˀ¹			cɛhˀ¹	cɛhˀ¹	cɛːʔ	cɛː	cɛː	cɛː	*cɛːˀ³	cɛːˀ⁵	cɛːˀ⁵⁶	cɛːˀ⁵	cɛːˀ⁵,	cɛːˀ⁵	cɛːˀ⁵	
322	fendu, fissuré, cracked, fissured	*ɗɛh	nɛᶜ¹										dɛhˀ¹	dɛːˀ⁶	dɛh					dɛːˀ⁵			rɛːˀ⁵			
323	naître, accoucher > pondre, be born, to give birth > to lay	*tɛh	ɗɛᶜ¹					tɛːˀ⁵⁶	kaɗæːʔ	tɛːˀ⁵	tɛhˀ¹	tɛhˀ¹	raɟɔːˀ³ cfˌʃoh	taɟuaˀ³ / lajɔːˀ³	ɟoh		tɛː		*tɛːˀ³	tɛːˀ⁵	tɛːˀ⁵⁶	tɛːˀ⁵	teːˀ⁵	tɛːˀ⁵	tɛːˀ⁵	
324	sangsue d'eau, water leech	*l-tɛh	ɗiəᶜ¹					paliːŋˀ¹	plɪːŋ	ntahˀ¹	tɛhˀ²		latahˀ¹	latahˀ¹	tatah	pliːŋ	piːŋ	pliːŋ	*pliːŋˀ¹	tɛːˀ⁶	diaˀ⁵⁶	tiaˀ⁵	tiaˀ⁵	tiaˀ⁵	diaˀ⁵	*p-liːŋ
325	excrément, faeces	*ʔɛh	ʔiəᶜ¹	ʔiəᶜ¹	ʔɛᴮ¹	ʔiəᴮ²			kɔcˀ⁷		kʰaʔɛːˀ³	kaʔɛːˀ³	kɨcˀ⁷			ʔɛː	ʔɛː	ʔɛː	*ʔɛːˀ³	ʔɛːˀ⁵	ʔɛːˀ⁵⁶	ʔɛːˀ⁵	ʔeːˀ⁵	ʔɛːˀ⁵		
326	ébréché, bec de lièvre, croissant de lune, chipped, harelip, crescent moon	*ɓɛh	mɛᶜ¹													bɛː		bɛː				mɛːˀ⁵	meːˀ⁵	mɛːˀ⁵		

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
327	torchon, rag	*k-cɛh	zɛ^{c1}																*cɛ:^{3}	cɛ:^{5}	jɛ:^{56}	cɛ:^{46}	cɛ:^{5}	cɛ:^{46}		
328	châtaigne, chestnut	*-tɛh	zɛ^{c1}																	tɛ:^{5}			tɛ:^{5}			
329	moineau, sparrow	*k-rɛh	sɛ^{c1}											sɛ:^{4}					*cɔ:k^{7}	k^{h}rɛ:^{5}	ʂɛ:^{56}	k^{h}ɛ:^{5}	k^{h}ɛ:^{5}	k^{h}ɛ:^{5}	k^{h}ɛ:^{5}	
330	panthère, panther	*pɛ:w	ɓɛw^{A1}																	pɛ:w^{1}	pɛ:w^{1}				bɛ:w^{1}	
331	suspendre, to hang	*k-lɛ:w	tɕɛw^{A1}					pəlew		talɛ:w^{1}			talɛ:w^{1}	talɛ:w^{1}	aliəw	klɛ:w	klɛ:w	klɛ:w	*klɛ:w^{1}	klɛ:w^{1}	ʈɛ:w^{1}		klɛ:w^{1}	klɛ:w^{1}		
332	chevrotin (Tragulus javanicus), mouse-deer (Tragulus javanicus)	*t-rɛ:w	tɕɛw^{A1}					tarɛ:w^{1}	tɛwtɛ:w^{1}	tɛ:w^{1}										k^{h}rɛ:w^{1}	cɛ:w^{1}					
333	aile, wing	*kɛ:ŋʔ	kɛŋ^{B1}					səpɛ:ŋ^{1}	səpɛ:ŋ^{1}	kɛ:ŋ^{3}	hapɛ:ŋ^{1}	apɛ:ŋ^{1}	ke:ŋ^{3}	ke:ŋ^{3}	sæ:p	kɛ:ŋ	kɛ:ŋ	kɛ:ŋ	*kɛ:ɲ^{3}	kwɛ:ŋ^{3}	kɛ:ŋ^{3}	kɛ:ɲ^{3}	kiɛŋ^{3}	kɛ:ɲ^{3}	kɛ:ɲ^{3}	*s-pɛ:ŋ
334	fourmi, ant	*kɛ:nʔ	kiən^{B1}	kin^{B1}	kiən^{B1}	kiən^{B1}		kəɲe:l^{4}	kəɲèarʔ	kəɲa:ɯ^{4}	keèn^{4} / kɛ:n^{3}	ki:n^{3}	kèɛm^{4}	kèɛm^{4}	nt^{h}iɛŋ	kɛ:n^{4}	kɛ:n	kɛ:n^{4}	*kɛ:n^{3} / kɛ:n^{4}	kɛ:n^{3}	ɣɛ:n^{4}	kiɛn^{3}	kiɛn^{3}	kiɛn^{3}	kiɛn^{3}	*k-ɲa:rʔ
335	cocon, cocoon	*kɛ:nʔ	kɛn^{B1}					kupi:^{1}						(culɛ:^{3})	təpi:^{1}					nɛ:ŋ^{2}	kɛ:n^{3}	kɛ:n^{3}	kɛ:n^{3}	kɛ:n^{3}		*k-pi:
336	fâné, withered	*hɛ:wʔ	hɛw^{B1}						sʔɔ:jʔ							hɛ:w	hɛ:w	hɛ:w	*hɛ:w^{3}	hɛ:w^{3}	hɛ:w^{3}	hɛ:w^{3}	hɛ:w^{3}	hɛ:w^{3}		*s-ʔɔ:jʔ
337	hirondelle, swallow	*ʔɛ:nʔ	ʔɛn^{B1}						ʔɛ:n^{1}		ʔɛ:n^{3}	ʔɛ:n^{3}					ʔɛ:n		*ʔɛ:n^{3}	ʔɛ:n^{3}	ʔɛ:n^{3}		ʔɛ:n^{3}		ʔɛ:n^{3}	
338	bouchée, morceau, mouthful, piece of,	*-mɛ:ŋʔ	miəŋ^{B1}	miŋ^{B1}	meŋ^{B1}	miəŋ^{B1}		mɛ:ŋ^{3}	mæ:ŋʔ	mɛ:ŋ^{3}			mɛ:ŋ^{3}	mɛ:ŋ^{3}	mɛ:ɲʔ	mɛ:ŋ	mɛ:ŋ	mɛ:ŋ	*mɛ:ŋ^{3}	mɛ:ŋ^{3}	maɲ^{3}	miɛŋ^{3}	miɛŋ^{3}	miɛŋ^{3}		
339	canne à sucre, sugarcane	*k-mɛ:ʔ	miə^{B1}					jè:m^{2}	jəamʔ	jəam^{2}	ɲi:m^{3}		kumè:^{4}	jəàm^{2}	atɛ:w	mɛ:	kmɛ:	mae	*kmɛ:^{4}	mɛ:^{4}	mia^{4}	mia^{3}	mia^{3}	mia^{3}	mia^{3}	*ja:m
340	lécher, to lick	*-lɛ:mʔ	liəm^{B1}	lim^{B1}	liəm^{B1}	niəm^{B1}		alɛ:m^{3}			həlɛ:m^{3}					lɛ:m	lɛ:m	laem	*lɛ:m^{4}	lɛ:m^{4}	lɛ:m^{4}		liɛm^{3}			
341	rivière, ruisseau, river, brook	*k^{h}ɛ:	xɛ^{A1}	suj^{B1}	suəj^{B1}	xɛ^{A1}		hɔ:ŋ^{3}	hɒ:ŋʔ	hɔ:ŋ^{3}	cilɔ:k^{8}	cilɔ:k^{8}	ʈɔ:k^{7}	ʈɔ:k^{7}												*b-la:wʔ
342	bambou commun, common bamboo	*k-lɛ:	tɕɛ^{A1}					x MlB x												p^{h}ɛ:w^{1}	fɛ:w^{1}	tlɛ:^{1}	klɛ:^{1}	klɛ:^{1}	fɛ:w^{1}	*p-hɛ:w
343	frère aîné, elder brother	*ʔɛ:ŋ	ʔɛŋ^{A1}																			ʔɛ:ŋ^{1}	ʔɛ:ŋ^{1}	ʔɛ:ŋ^{1}		
344	piège (tonilière), a kind of trap	*sɛ:l	tɛ^{A1}															saɛl	*sɛ:l^{1}							
345	de côté, on the side of	*s-gɛ:ŋ	ŋiəŋ^{A1}	ŋiəŋ^{A1}	ŋiəŋ^{A1}	ŋiəŋ^{A1}				pəkeɛŋ^{2}	cəkeèŋ^{2}		cəke:ŋ^{2}	təke:ŋ^{2}			tkɛ:ŋ		*ckɛ:ŋ^{2}	ŋiɛŋ^{1}	ŋiɛŋ^{1}		ŋiɛŋ^{1}	ŋiɛŋ^{1}		
346	herbe à paillote, thatch-grass	*p-lɛɲ	tɕɛŋ^{A1}							kəlaɲ^{1}			məlɛŋ^{2}		lèɲ						ʈaɲ^{1}					*paːjʔ
347	(sorte de) silure, (kind of) catfish	*c-lɛ:l	tɕe^{A1}										calèɛl^{2}									tliel^{1}	kliə^{1}	kle:l^{1} / kliɛl^{1}		
348	levure, yeast	*-mɛ:n	mɛn^{A1}														pʰla:ŋ	pʰla:ŋ	*pʰra:ŋ^{1}							*p-ra:ŋ
349	croisé (bras, jambes), to cross (arms, legs)	*k-vɛ:ŋ	x^{w}ɛŋ^{A1}							k^{h}wɛ:ŋ^{1}			k^{h}wɛ:ŋ^{1}	k^{h}wɛ:ŋ^{1}	k^{h}wɛŋ					k^{h}wɛ:ŋ^{1}	k^{h}wɛ:ŋ^{1}					
350	haïr, to hate	*t-kɛ:t	ɣɛt^{D1}							təkɛ:t^{7}			təkɛ:t^{7}	təkɛ:t^{7}	kiet	kɛ:t	tkɛ:t	kɛ:t	*tkɛ:t^{7}	kɛ:t^{7}	ɣɛ:t^{7}		kɛ:t^{7}	kɛ:t^{7}	kɛ:t^{7}	
351	visiteur, guest	*k^{h}ɛ:k	xɛk^{D1}					təmɔ:j^{1}							təmɑ:j		k^{h}ɛ:k		*k^{h}ɛ:k^{7}	k^{h}ɛ:k^{7}	k^{h}ɛ:k^{7}		k^{h}ɛ:k^{7}	k^{h}ɛ:k^{7}		*t-mɔ:j
352	enfant, child	*dɛ:t	nit^{D1}					manɛ:^{2}					pacɔ:j^{1}				dɛ:t		*dɛ:t^{7}	dɛ:t^{7}	dɛ:t^{7}	dɛ:t^{7}	rɛ:t^{7}	dɛ:t^{7}	
353	puce, flea	*cɛ:t	tɕɛt^{D1}					tamat^{1}	tamat^{1}	sama:^{1}			camɛ:^{1}	camɛ:^{1}		cɛ:t	cɛ:t	cɛ:t	*cɛ:t^{7}	cɛ:t		ta:^{1} ma:^{1}	ta:^{1} ma:^{1}	ta:^{1} ma:^{1}		*s-ma:
354	sourd, deaf	*tɛ:k	ɗiək^{D1}	ɗik^{D1}	ɗiək^{D1}	ɗiək^{D1}					teɛk^{8}		ti:k^{8}	ti:k^{8}			ta:j	ta:j	*ta:j^{2}	te:j^{2}	diɛk^{7}	tiɛk^{7}	tiɛk^{7}	tiɛk^{7}	diɛk^{7}	*da:j
355	tique, tick	*k-pɛ:t	vɛt^{D1}						apæ:t	kapɛ:t^{1}	kapɛ:t^{7}	kapɛ:t^{7}	kapɛ:t^{7}	kapɛ:t^{7}		pɛ:t	kpɛ:t	pɛ:t	*kpɛ:t^{7}							
No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN	VN Vinh	Maleng	Maleng Bro	Maleng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ	Thổ Làng Lỡ	Mường Bi	Mường	Mường Sơn La	Mường	Proto Vietic1

						Diêm Điền		Kha Phong		Mã Liềng										Cuối Chăm			Hoà Bình		Thanh Hoá	
356	petite crevette, crayfish	*sɛ:p	tɛp^{D1}					so:m^{1}												so:m^{2} kʰrɛ:p^{7}	sɛ:p^{7}	tʰɛ:p^{7}	tʰɛ:p^{7}	sɛ:p^{7}	sɛ:p^{7}	
357	déchiré, torn	*sɛ:k	sɛ^{B1}													sɛ:k	sɛ:k		*sɛ:k^{7}	sɛ:k^{7}			cɛc^{7}	cɛc^{7}		
358	aisselle, armpit	*-nɛ:k	nɛk^{D1}					tukɛ:k^{7} /səva:k^{7}	siva:k	tukɛ:k^{7}	tʰava:k^{7}	va:k^{7}	təva:k^{7}	ruva:k^{7}	ivɒ:k	ʔɛknɛ:k	kɛ:k	mɛcmɛ:c	*nɛ:k^{7}	kɛkkɛ:k^{7}	nɛ:k^{7}	nɛ:c^{7}	nɛ:k^{7}	kɛ:c^{7}	nɛ:c^{7}	*s-va:k
359	foudre, lightning	*p-rɛ:t	sɛt^{D1}																*pʰrɛ:t^{7}	sɛ:t^{7},	ʂɛ:t^{7}		kʰɛ:t^{7} S fɛ:t^{7},		kʰɛ:t^{7}	
360	rouille, rust	*p-rɛ:t	sɛt^{D1}													pʰlɛ:t		pʰlɛ:t	*pʰrɛ:t^{7}							
361	col, collar	*ʔɛ:w	ɗɛw^{A2}										ʔɛ:w^{1}	ʔɛ:w^{1}		ʔɛ:w^{1}			*ʔɛ:w^{1}	ʔɛ:w^{1}			- S -,			
362	grimper, to climb	*g-lɛ:w	tɕɛw^{A2}																*klɛ:w^{2}	klɛ:w^{2}	ʐiɛw^{2}	tɛ:w^{2}	tɛ:w^{2}	cɛ:w^{2}	tɛ:w^{2}	
363	chat, cat	*mɛ:w	mɛw^{A2}																							
364	épi, ear (of grains)	*k-cɛ:rʔ	tɕɛn^{B2}							cɛ:ɯ^{3}												x Nguôn cɛ:n^{4}	(po:ŋ^{1})			
365	bouche, mouth	*mɛ:ŋʔ	miəŋ^{B2}	mom^{A2}	muəm^{A2}	mom^{A2}	mɛ:ŋ^{B2}	mɛ:ŋ^{3}					ka:ŋ^{3}	ka:ŋ^{3}	kæ:ŋʔ	mɛ:ŋ	mɛ:ŋ	mɛ:ŋ	*mɛ:ŋ^{4}	mɔ:m^{1}	bɔ:^{56}	mo:m^{2}	mo:m^{2}	mɛ:ŋ^{4} / mo:m^{2}	mo:m^{2}	*-mo:m
366	s'étouffer (en mangeant), choke (while eating)	*ŋɛ:nʔ	ŋɛn^{B2}										ʔo:l^{3}	ʔu:l^{3}	ʔuəlʔ	ŋɛ:n	ŋɛ:n	ŋaen	*ŋɛ:n^{4}	ʔɔ:l^{3}	ŋeɛn^{4}	ŋɛ:n^{46}	ŋɛ:n^{4}	ŋɛ:n^{46}		*ʔo:lʔ
367	léger, light (in weight)	*-ɲɛ:lʔ	ɲɛ^{B2}				ɲɛn^{B2}	ŋɛ:l^{3}		ŋɛ:l^{3}			ɲɛ:l^{3}	ɲɛ:l^{3}		ɲɛ:n		ɲaɛl	*ɲɛ:l^{3}	ɲɛ:l^{3}	ɲɛ:n^{4}	ɲɛ:l^{46}	ɲaə^{3}	ɲɛ:l^{46}	ɲɛ:n^{46}	
368	curcuma, turmeric	*ŋɛ:lʔ	ŋe^{B2}	ŋe^{B2}	ŋɛ^{B2}	ŋe^{B2}														ŋe:^{4}	ŋe:^{4}	ŋɛ:l^{46}	ŋɛ:ə^{4}	ŋɛ:l^{46}		
369	marmite, pot	*ŋɛ:ʔ	ŋɛ^{B2}													ŋɛ:	ŋɛ:	ŋae	*ŋɛ:^{4}							
370	tirer la langue, to pull out tongue	*t-lɛ:l	lɛ^{A2}					talɛ:l^{2}		talɛ:l^{2}			lɛlɛ:^{2}	lɛlɛ:^{2}	lelè:			daɛl	*kdɛ:l^{3}	dɛ:l^{3}				lɛ:l^{46} | lɛ:l^{2}		*k-ɗɛ:lʔ
371	branche, branch	*gɛ:ŋ	kɛŋ^{A2}					təkɛ:ŋ^{3}		təkɛ:ŋ^{3}			təkɛ:ŋ^{3}	təkɛ:ŋ^{3}	kɑ:ŋʔ	ca:ŋ	kca:ŋ	ca:ŋ	*kca:ŋ^{3}	pɛ:ŋ^{2}	ŋɛ:ŋ^{3}	kɛ:ŋ^{2}	kiɛŋ^{2}	kɛ:ŋ^{2}	kɛ:ŋ^{2}	*k-ca:ŋʔ
372	graine, noyau, seeds, kernel	*-hɛ:k	hɛk^{D2}													hɛ:t	hɛ:k	hɛ:c	*hɛ:k^{8}	hɛ:k^{8}	hɒ:t^{8}					
	VOWEL *a:																									
373	étoffe de coton, cotton cloth	*k-pa:s	va:j^{c1}					kəpa:j^{5}	krdǫ:ʔ	kəpa:ɯ^{h1}	kəpaj^{h1}	kəpaj^{h1}	kupa:l^{6}	kupa:l^{6}	kupɛ:lʔ				*kpa:j^{1}	pa:l^{5}	pa:n^{56}	pa:j^{5}	pa:j^{5}	pa:j^{5}	ba:j^{5}	
374	frapper de la main, gifler, to hit with hand, to slap	*t-pah	va^{c1}					təpa:^{5}	təpa:ʔ	təpah^{1}	təpah^{1}		təpah^{1}	təpah^{1}	mpah					pa:^{5}		pa:^{5}				
375	vomir, to vomit	*ɓah	mɨə^{c1}	ma^{c1}	mɨə^{B1}	mɨə^{B2}		ba:^{5}		bah^{1}			bah^{1}	bah^{1}	abah	ba:	ba:	ba:	*ba:^{3}	ba:^{5}	ba:^{56}		fa:^{5}	ba:^{5}	va:^{5}	
376	choux moutarde (Brassica), cabbage mustard (Brassica)	*ka:s	ka:j^{c1}					ka:j^{56}	ka:jʔ	ka:l^{4}	kajh^{1}	kajh^{1}	ka:l	ka:l^{4}		ka:c	ka:t	ka:c	*ka:c^{7}	ka:l^{5}	ka:j^{56}	ka:j^{5}	ka:j^{5}	ka:j^{5}		
377	couler, ruisseler, to stream, run	*cas	tɕaj^{c1}					cɐl^{4}		caɯ^{4}		salo:j^{1}	tuh^{1}						*klo:j^{1}	cal^{5}	can^{56}	caj^{5}	caj^{5}	caj^{5}	caj^{5}	
378	écaille > opercule, scale (of fish) > operculum	*k-pas	vaj^{c1}					karaj^{56}		kəpaɯ^{h1}	kəpɛh^{1}	kəpɛh^{1}	kakah^{1}			pac	kpɛk	pac	*kpac^{7}	pal^{5}	pan^{56}	pac^{7}	paj^{5}	pac^{1}	baj^{5}	
379	fendre (du bois), to split (wood)	*pah	ɓɨə^{c1}	ɓɨə^{c1}	ɓɨə^{B1}	ɓɨə^{B2}		pɐ:^{6}	pɨaʔ	pəah^{2}			pə̀ah^{2}	apə̀ah^{2}		pa:	pa:	pa:	*pa:^{4}	pɐ:^{6}		pɨa^{5}	pɨa^{5}	pɨa^{5}		
380	omoplate, scapula	*pah	ɓa^{c1}					sala:p^{7}		kala:p^{7}			kla:p^{7}	tla:p^{7}						ba:^{4}		pa:^{5}	pa:^{5}	pa:^{5}		*k-la:p
381	peigner, to comb	*ca:s	tɕa:j^{c1}					se:k^{7}	sẹ:k	ca:ɯ^{h1}								ca:c	*ca:c^{7}	ca:l^{5}	ca:n^{56}	ca:j^{5}		ca:j^{5}	ca:j^{5}	*se:k
No.	**GLOSS**	**Proto Vietic**	**VN** Hanoi	**VN** Cổ Định	**VN** Nghi Ân	**VN**	**VN** Vinh	**Maleng**	**Maleng** Bro	**Maleng**	**Thavung**	**Thavung**	**Chứt** Rục	**Chứt** Sách	**Arem**	**Pong** Liha	**Pong** Phong	**Pong** Toum	**proto Pong**	**Thổ**	**Thổ** Làng Lỡ	**Mường** Bi	**Mường**	**Mường** Sơn La	**Mường**	**Proto Vietic1**	

						Diêm Điền		Kha Phong		Mã Liềng		Phon Soung								Cuối Chăm			Hoà Bình		Thanh Hoá	
382	pamplemousse, pomelo	*paːs	ɓɨəjᶜ¹	ɓɨnᶜ¹	ɓɨəjᴮ¹	ɓɨəjᴮ²				pɨəlᴴ⁴											paːn⁵⁶	pɨəj⁵	pɨəj⁵	pɨəj⁵	bɨəj⁵	
383	grand, important, aîné(e), large, important, senior	*kah	kaᶜ¹																ka:⁵	ka:⁵⁶	ka:⁵	ka:⁵	ka:⁵			
384	éternuer, to sneeze	*k-cas	ɲajᶜ¹													cac	kcɛk T,		*kcac⁷				caj⁵			
385	enflé, swollen	*kas	cayr mur	kəŋᴮ¹	sɨŋᴬ¹	kajᴮ²	kajᶜ¹									kac	kɛk	kac	*kac⁷	kalᴴ⁶						
386	(couché) sur le dos, (to lie) on the back	*t-ŋah	ŋɨəᶜ¹	ŋaᶜ¹	ŋʷaᴮ¹	ŋɨəᴮ²		pəŋa:⁵		ŋah			təŋahᴴ¹	təŋahᴴ¹	aŋ̀ìəh	ŋa:	pəŋa:	ŋa:	*pŋa:³	ŋa:⁵	ŋa:⁵⁶	ŋa:⁵	ŋa:⁶	ŋa:⁵		
387	main de banane, hand of bananas	*c-naːs	naːjᶜ¹										caːlᴴ⁶	caːlᴴ⁶		naːc		naːc	*naːc⁷		naːj⁵⁶	naːj⁵	naːj⁵	naːj⁵		
388	tombeau, tomb	*-mah	maᶜ¹										mahᴴ¹	mahᴴ¹						maː⁵	maː⁵⁶	maː⁵	maː⁵	maː⁵	maː⁵	
389	épaule, shoulder	*ɓaːj	vaːjᴬ¹					salaːŋᴴ¹	cilaːŋ	kalaːŋᴴ¹			kalaːŋᴴ¹	kalaːŋᴴ¹	kalæːŋ	baːj	baːj	baːj	*baːjᴴ¹	paːjᴴ¹	βəaːjᴴ¹	vaːjᴴ¹	vaːjᴴ¹	baːjᴴ¹	vaːjᴴ¹	*k-laːŋ
390	oreille, hear	*saːj	taːjᴬ¹					saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	tʰaːj	saːj	patsaːj	batsaːj	*saːjᴴ¹	saːjᴴ¹	saːjᴴ¹	tʰaːjᴴ¹	tʰaːjᴴ¹	saːjᴴ¹	saːjᴴ¹	
391	placenta, placenta	*ʃaw	ɲawᴬ¹					ʔɛːmᴴ¹		ʔaːwᶟ			ɟawᴴ¹	ɟawᴴ¹	ɟawᴴ¹					ɲawᴴ¹	ʐawᴴ¹	ʔaːwᶟ	ʔaːwᶟ	ʔaːwᶟ	ʔaːwᶟ	*ʔaːwʔ
392	aréquier, areca	*kaw	kawᴬ¹										kawᴴ¹	kawᴴ¹		kaw	kaw	kaw	*kawᴴ¹		kawᴴ¹		kawᴴ¹	naːŋᴴ¹		
393	couteau, knife	*-taːw	zaːwᴬ¹													taːw		taːw	*taːwᴴ¹	taːwᴴ¹	ðəaːwᴴ¹	taːwᴴ¹	taːwᴴ¹	taːwᴴ¹	taːwᴴ¹	
394	pupille (de l'oeil), pupil (of the eye)	*-ŋaːj	ŋɨəjᴬ¹										ŋaːjᴴ¹							ŋaːjᴴ¹	ŋɨəjᴴ¹		ŋɨəjᴴ¹	ŋɨəjᴴ¹		
395	ruminer, ruminate	*-ɲaːj	ɲaːjᴬ¹							ɲaːjᴴ¹									*ɲaːᶟ							
396	étoile, star	*k-raːw	saːwᴬ¹													baɛ	kbeː	bae	*kbeːᴴ¹	kʰraːwᴴ¹	ʂaːwᴴ¹	kʰaːwᴴ¹	kʰaːwᴴ¹	kʰaːwᴴ¹	kʰaːwᴴ¹	*k-ɓeː
397	légumes, vegetables	*-raw	zawᴬ¹	zawᴬ¹	[raeo]	zawᴬ¹										ɣaw	ʰlaw	ʰraw	*rawᴴ¹	rawᴴ¹	ʐawᴴ¹					
398	brouet de riz, soupe|rice gruel	*caːwʔ	tɕaːwᴮ¹					ulɔːŋᴴ⁴	atɛ̀k	cawcaːwᶟ			caːwᶟ	caːwᶟ	cɛːwʔ				*laːwᴴ¹	caːwᶟ	caːwᶟ	caːwᶟ	caːwᶟ	caːwᶟ	caːwᶟ	
399	calebasse, écope, calabash, gourd	*-kaːwʔ	ɣaːwᴮ¹							kə̀awᴴ⁴					kɛːwʔ					jɛːwᶟ		kaːwᶟ	ɣaːwᶟ			
400	chanter (coq), to crow (cock)	*t-karʔ	ɣajᴮ¹							təkaɯᶟ			təkalᶟ	təkalᶟ	ikalʔ	kan		kal	*kalᶟ	kalᶟ	kanᶟ		kaəᶟ	kalᶟ		
401	épouse fr aîné du père, soeur aînée de père/mère, fathers's elder brother's wife, father or mother's elder sister	*paːʔ	ɓaᴮ¹					paːᴴ⁴	pə̀aʔ				jaːᶟ		ʔɑː					mɔːᴴ⁴ paːᶟ	jaːᴴ⁴	paːᶟ	paːᶟ	paːᶟ	paːᶟ	
402	huit, eight	*saːmʔ	taːmᴮ¹					saːmᶟ Pk saːmᶟ		tʰaːmᶟ	saːmᶟ	saːmᶟ	tʰaːmᶟ	tʰaːmᶟ	tʰæːmʔ	saːm	saːm	saːm	*saːmᶟ	saːmᶟ	taːmᶟ	tʰaːmᶟ	tʰaːmᶟ	saːmᶟ	saːmᶟ	
403	incendie, conflagration	*k-carʔ	tɕajᴮ¹					kəcalᶟ	kacarʔ	kəcaɯᶟ	canᶟ	calᶟ			calʔ	can		cal	*calᶟ	calᶟ	canᶟ	calᶟ	caəᶟ	calᶟ		
404	ouvrir (bouche), to open (mouth)	*haːʔ	haᴮ¹					haːᶟ	haːʔ	haːᶟ	hɛ̀ːᴴ⁴	hɛ̀ːᴴ⁴	haːᶟ	haːᶟ	hɑːʔ	haːŋ	haːŋ	haːŋ	*haːŋᶟ			haːᶟ	haːᶟ			*haːŋʔ
405	papier, paper	*k-cajʔ	zəjᴮ¹							kəcɛjᶟ			kəcajᶟ	kəcajᶟ	kacajʔ					jʌjᶟ	jʌjᶟ	cəjᶟ	zəjᶟ	cəjᶟ		
406	pierre, stone	*l-taːʔ	ɗaᴮ¹							tətaːᶟ			lataːᶟ	taːᶟ	atæːʔ	taː	taː	taː	*taːᶟ	taːᶟ	ðaːᶟ					
407	poisson, fish	*ʔa-kaːʔ	kaᴮ¹					akaːᶟ	akaːʔ	akaːᶟ	kaːᶟ Th kaːᶟ		kaːᶟ	akaːᶟ	akæːʔ	kaː	kaː	kaː	*kaːᶟ	kaːᶟ	kaːᶟ		kaːᶟ	kaːᶟ kaːᶟ	kaːᶟ	
408	salaison (crevette, poisson), to salt (shrimp, fish)	*ɓamʔ	mamᴮ¹					bamᶟ	bamʔ	bamᶟ			bamᶟ	bamᶟ	bamʔ				*bamᶟ	bamᶟ	bamᶟ	bamᶟ	vamᶟ	bamᶟ		

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
409	scrotum, scrotum	*k-ta:lʔ	za:j^{B1}	ɗa:n^{B1}	zʷa:j^{B1}	za:j^{B1}		kəta:l^{3} Pk kəta:r,	kta:lʔ		kəta:l^{1}	kata:n^{3}	kəta:l^{3}	kəta:l^{3}	atæ:lʔ	ta:n	kta:l	ta:n	*kəta:l^{3}	ta:l^{3}	ta:n^{3}	ta:l^{3}	ta:ə^{3}	ta:l^{3}	ta:n^{3}	
410	son, bran	*t-ka:mʔ	ka:m^{B1}								kăpəh^{1}	kăpəh^{1}			kæ:mʔ	kamka:m		kamka:m	*tka:m^{3}	ka:m^{3}	ɣa:m^{3}		ka:m^{3}	klaw^{3}	kʰa:m^{3}	
411	tigre, tiger	*k-ha:lʔ	xa:j^{B1}					mɛ:w^{1}			kəha:l^{1}		kuha:l^{3}	kuha:l^{3}	miəw	kʰa:n		kʰa:l	*kʰa:l^{3}	kʰa:l^{3}			mɔ:ŋ^{1}	kʰa:l^{3}	kʰa:n^{3}	*-me:w
412	veste, vêtement du haut, jacket, upper garment	*ʔa:wʔ	ʔa:w^{B1}					ʔa:w^{3}	ʔa:wʔ	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔɛ:wʔ	ʔa:w	ʔa:w	ʔa:w	*ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	ʔa:w^{3}	
413	voeuf, widowed	*-kwa:ʔ	ɣʷa^{B1}					ma:j^{1}	pʰoma:j^{1}	kajaw^{3}	kama:j^{1}	kama:j^{1}	kajaw^{3}	kajaw^{3}	kajawʔ		kʰla:	kʰla:	*kʰra:^{4}	kwa:^{3}	ɣwa:^{3}	kwa:^{3}	kwa:^{3}	kwa:^{3}	kʰwa:^{3}	*k-jawʔ
414	amer, bitter	*taŋʔ	ɗaŋ^{B1}					taŋ^{3}	taŋʔ	taŋ^{3}	taŋ^{3}		taŋ^{3}	taŋ^{3}		taŋ		taŋ	*taŋ^{3}	taŋ^{3}	taŋ^{3}		taŋ^{3}	taŋ^{3}	daŋ^{3}	
415	ruer (cheval), rush (horse)	*ta:ʔ	ɗa^{B1}							handa:^{3}			ta:^{3}						*te:^{3}	ta:^{3}	ta:^{3}	ta:^{3}	ta:^{3}	ta:^{3}		
416	toit, roof	*ɓa:lʔ	ma:j^{B1}										ba:l^{3}	ba:l^{3}		bɔ:ŋ	kbɔ:ŋ	bɔ:ŋ	*kbɔ:ŋ^{1}	ma:j^{3}	ma:j^{3}					*k-ɓɔ:ŋ
417	ananas, pineapple	*-ca:ʔ	zɨə^{B1}											cəaj^{4}						cɨa^{3}	jɨa^{3}	zɨa^{3}	zɨa^{3}	zɨa^{3}		
418	pandanus, natte, pandanus, mat	*ɲca:rʔ	tɕiəw^{B1}								pəsah^{1}			aca:l^{3}		ca:n		ca:l	*ca:l^{3}							*p-sah
419	griller (sur la braise), to roast (on embers)	*ɗa:ŋʔ	nɨəŋ^{B1}	na:ŋ^{B1}	nʷa:ŋ^{B1}	nɨəŋ^{B1}	na:ŋ^{B1}	da:ŋ^{3}		da:ŋ^{3}	salaŋ^{1}	ada:ŋ^{3}				na:ŋ	na:ŋ	na:ŋ	*na:ŋ^{3}	da:ŋ^{3}	da:ŋ^{3}	na:ŋ^{3}	na:ŋ^{3}	na:ŋ^{3}	na:ŋ^{3}	
420	hanche, hip	*k-ha:ŋʔ	ha:ŋ^{B1}					kuha:ŋ^{3}																		
421	récolter, cueillir, to harvest, to gather	*ha:rʔ	ha:j^{B1}							ha:ɯʔ										ha:j^{3}	ha:j^{3}	ha:j^{3}	ha:j^{3}	ha:j^{3}	ha:j^{3}	
422	briller, chaud (soleil), to shine, hot (of sun)	*ɗaŋʔ	naŋ^{B1}																		daŋ^{3}	daŋ^{3}	raŋ^{3}	daŋ^{3}		
423	conduite, tuyau, conduit, pipe	*ɓa:ŋʔ	ma:ŋ^{B1}	mɨəŋ^{B1}	mʷa:ŋ^{B1}	ma:ŋ^{B1}														ba:ŋ^{3}		ma:ŋ^{3}	ma:ŋ^{3}	ma:ŋ^{3}		
424	mordre, piquer, to bite, to sting	*kaŋʔ	kan^{B1}									akiŋ^{3}										kaŋ^{3}	kaŋ^{3}	kaŋ^{3}		
425	papillon, butterfly	*pa:mʔ	ɓɨəm^{B1}														pampa:m	pampa:m	*pa:m^{3}		pəmpɨam^{3}	pɨəm^{1} pɨəm^{3}	pɨəm^{1} pɨəm^{3}	pɨəm^{3}	bɨəm^{3}	
426	vendre, to sell	*pa:ɲʔ	ɓa:n^{B1}													paːɲ	pa:n T, pa:ɲ		*pa:ɲ ^{3}	pa:n^{3}	pa:n^{3}	pa:ɲ^{3}	pa:ɲ^{3}	pa:ɲ^{3}	ba:ɲ^{3}	
427	(fils) mâle, male (son)	*ʔa:jʔ	ɗɨə^{B1}													ʔa:j	ʔa:j	ʔa:j	*ʔa:j^{3}							
428	au-dessous, under	*-ta:lʔ	zɨəj^{B1}	ɗɨn^{B1}	tɕɔj^{A1}	zɨəj^{B1}										ta:n		ta:l	*ta:l^{4}		pə:ŋ^{3}					
429	il, elle, he, she	*hanʔ	han^{B1}													han	han	han	*han^{3}	han^{3}						
430	manche, handle	*ka:nʔ	ka:n^{B1}													ka:n	ka:n	ka:n	*ka:n^{3}	ka:n^{3}	ka:n^{3}					
431	dur, solide, hard, firm	*k-sanʔ	zan^{B1}														ksan		*ksan^{3}							
432	âme, esprit, soul, spirit	*r-va:jʔ	viə^{B1}					rəvɛ:j^{4}	ravɨajʔ		ava:j^{3}		va:j^{3}	va:j^{3}	va:jʔ	va:j	va:j	va:j	*va:j^{3}	va:j^{3}	via^{3}	wa:j^{46}	wa:j^{3}	va:j^{46}	va:j^{3}	
433	jupe, skirt	*valʔ	vaj^{B1}				mən^{A1}	ncɛ:m^{3}	ncæ:mʔ		cɛ:m^{3}	canɛ:m^{3}	apèn^{2}	apèn^{2}	apèn	baən		bʌ:l	*bə:l^{3}		vaj^{3}	wal^{3}	vaə^{3}	val^{3}	van^{3}	*ɓə:lʔ
434	arbalète, cross-bow	*s-na:ʔ	na^{B1}					səna:^{3} Pk sna:^{3}		na:^{3}			na:^{3}	na:^{3}	næ:ʔ	na:	sna:	na:	*sna:^{3}	na:^{3}	no:^{56}	na:^{3}	na:^{3}	na:^{3}	na:^{3}	
435	bambou mince (Thyrsostachys siam), thin bamboo (Thyrsostachys siam)	*-na:ʔ	nɨə^{B1}	na^{B1}	nʷa^{B1}	nɨə^{B1}									ănièʔ		na:	na:	*na:^{3}	na:^{3}	na:^{3}					

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
436	chemin| way, path	*k-ra:ʔ	saᴮ¹								kʰəla:³				uræ:ʔ	kʰla:		kʰla:	*kʰra:³				tʰa:³	kʰa:³	kʰa:³	
437	feuille, leaf	*s-la:ʔ	laᴮ¹					sla:³ Pk sra:³		ula:³	sla:³		ula:³	la:³	ulæ:ʔ	la:	kʰla:	la:	*kʰra:³	la:³	la:³	la:³	la:³	la:³	la:³	
438	loin, far	*s-ŋa:jʔ	ŋa:jᴮ¹							təŋa:j³ Kp,Pk səŋa:j³	səŋàaj⁴		ciŋa:j³	təŋa:j³	ŋa:jʔ	ŋa:j	ŋa:j	ŋa:j	*ŋa:j³	ŋa:j³	ŋa:j³					
439	mâcher, chiquer, to chew, chew tobacco	*s-ɲa:ʔ	ɲaᴮ¹					səŋa:³ Pk aŋa:³,			aŋa:³		təŋa:³		aɲæ:ʔ	ɲa:	ɲa:	ɲa:	*ɲa:³	ɲa:³						
440	manioc, cassava	*s-ranʔ	sanᴮ¹										ʐan³ / sran³	ʐan³	ranʔ						ʂan³					
441	mois, month	*k-ra:ŋʔ	tʰa:ŋᴮ¹						-	tʰa:ŋ³	tʰa:ŋ¹		tʰa:ŋ³	tʰa:ŋ³	tʰæ:ŋʔ	kʰla:ŋ	kʰla:ŋ	kʰla:ŋ	*kʰra:ŋ³	kʰra:ŋ³			kʰa:ŋ³	kʰa:ŋ³	kʰa:ŋ³	
442	ronfler en dormant, to snore	*t-ŋarʔ	ŋajᴮ¹						səŋɔ:rʔ	aŋaɯ³			təŋəl⁴	təŋəl⁴	aŋèlʔ	ŋan⁴	săŋal³	ŋal³	*snal³	ŋal⁴	ŋan⁴	ŋal³	ŋaə³	ŋal³		
443	blanc (de l'oeil, de l'oeuf), whites (of the eyes/eggs)	*k-laŋʔ	tɕaŋᴮ¹							taka:l¹			taka:l¹	taka:l¹					*pa:k⁸	(pɛ:k⁸)	ʈaŋ³	tlaŋ³	klaŋ³	klaŋ³		*t-ka:l
444	entendre, to hear	*c-maŋʔ	maŋᴮ¹								təmèŋ⁴		cəmaŋ³	cəmaŋ³		ŋɛ:	ŋɛ:	ŋɛ:	*ŋɛ:¹				maŋ¹	maŋ¹	maŋ¹	*ŋɛ:
445	frire, to fry	*-ra:ŋʔ	za:nᴮ¹							ɣa:ŋ³			ura:ŋ³	ra:ŋ³						ra:n³	ʂa:n³		ra:n³	tʰa:n³	ra:n³	*-ra:nʔ
446	front, forehead	*k-la:ɲʔ	tɕa:nᴮ¹									kala:ɲ³	kla:ɲ³	tla:ɲ³					*kla:ɲ³	kla:n³	ʈa:n³	tla:ɲ³	kla:ɲ³	kla:ɲ³	ʈa:ɲ³	
447	joue, cheek	*-ma:ʔ	maᴮ¹					po:p⁷			pɔ̀:m²	pɔ:m²	poɔ̀m²	poɔ̀m²					*kpɛ:wᴸ¹	ma:³	ma:³	ma:³	ma:³	ma:³	ma:³	*bɔ:m
448	merle, blackbird	*k-ra:wʔ	sa:wᴮ¹				tɕa:wᴮ¹						pàawᴴ⁴	pàawᴴ⁴						kʰra:w³	ʂa:w³	kʰa:w³	kʰa:w³	kʰa:w³	kʰa:w³	*ba:wʔ
449	(lune) brille, clair, to shine (moon), bright	*p-la:ŋʔ	sa:ŋᴮ¹													kla:ŋ	kla:ŋ	kla:ŋ		bla:ŋ³	sa:ŋ³	kʰa:ŋ³		bla:ŋ³		
450	poignée, contenant d'une main, handful, contents of hand	*-namʔ	namᴮ¹																*kɲam³			nam³	nam³	nam³		
451	gauche, left	*k-la:jʔ	tɕa:jᴮ¹													kla:j	kla:j	pla:j	*kla:j³	kla:j³	ʈa:j³		ciɛwᴸ¹			
452	poing, contenant d'une main, fist, contents of hand	*k-ɲamʔ	namᴮ¹													ɲam		ɲam	*kɲam³							
453	rugueux, rough	*-ɲa:mʔ	ɲa:mᴮ¹													ɲa:m		ɲa:m	*ɲa:m³							
454	banian, banyan	*ta:	ɗaᴬ¹					sĭri:²	cĭrì:	mətàa²	tʰi:²		ʈi:²	ʈi:²	cirì:	kʰləi	kʰli:	kʰlei	*kʰri:²	ta:¹	ɓa:¹		ta:¹	ta:¹	da:¹	*ɟ-ri:
455	délayer, mélanger, dilute, mix	*pʰa:	faᴬ¹					pʰa:¹		pʰa:¹			pʰa:¹	pʰa:¹	pʰæ:					pʰa:¹	fa:¹	fa:¹		fa:¹		*k-vər
456	pluie, rain	*kʰma:	mɨəᴬ¹	mɨᴬ¹	mɨəᴬ¹	mɨəᴬ¹							kumàa²	kumàa²	mìə	ma:	kʰma:	ma:	*kma:²	mɛ:²	mɨa¹	mɨa¹	mɨa¹	mɨa¹	mɨa¹	
457	trois, three	*pa:	ɓaᴬ¹					pa:¹	pa:	pa:¹	pa:¹ R pa:¹		pa:¹	pa:¹	pæ:	pa:	pa:	pa:	*pa:¹	pa:¹	pa:¹	pa:¹	pa:¹	pa:¹	ba:¹	
458	jambe, patte, leg, foot	*kaŋʰ	kaŋᶜ¹																	kaŋ⁵	kaŋ⁵⁶		kaŋ⁵			
459	peau, skin	*-ta:	zaᴬ¹																				ta:¹	ta:¹ THta:¹,		
460	midi| midday, noon	*k-la:	tɕɨəᴬ¹					kʰala:¹		kalɨa¹			pakɔhᴸ¹		ciliə				*kla:⁴	klɛ:²	pa:n²		klɨa¹	tlɨa¹	tlɨa¹	
461	génie, fantôme, spirit, ghost	*-ma:	maᴬ¹													ma:	sama:	ma:	*sma:¹	ma:¹ et						

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN	VN Vinh	Maleng	Maleng Bro	Maleng	Thavung	Thavung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ	Thổ Làng Lỡ	Mường Bi	Mường	Mường Sơn La	Mường	Proto Vietic1

						Diêm Điền		Kha Phong		Mã Liềng		Phon Soung								Cuối Chăm			Hoà Bình		Thanh Hoá	
462	(enfant) naturel, natural (child)	*k-ja:ŋ	hʷa:ŋ^{A1}					kaja:ŋ^{1}					kaja:ŋ^{1}	kaja:ŋ^{1}	kajæ:ŋ		klə:j	klaəj	*klə:j^{1}							*k-lə:j
463	à droite, right side	*tam	ɗam^{A1}					tɐm^{2}		tɐm^{2}			tèm^{2}	tèm^{2}	tèm				*tɨk^{1}			tam^{1}	tam^{1}	tam^{1}	dam^{1}	
464	cadet, cadette|younger sibling	*k-sa:m	ʔɛm^{A1} (tam)							ceɛʔ	sa:m^{1}	sa:m^{1}	cèɛ^{4}	cèɛ^{4}	kat^{h}æ:m	ʔɛ:m	ʔɛ:m	ʔɛ:m	*ʔɛ:m^{1}	ʔɛ:m^{1}	ʔɛ:m^{1}	ʔu:n^{3}	ʔu:n^{3}	ʔu:n^{3}	ʔu:n^{3}	*ɟɛ:ʔ
465	chevreuil, deer	*t-ɓa:ŋ	ma:ŋ^{A1}					po:j^{56}	pǫ:jʔ	po:j^{h1}	hakʌ:j^{1}	pɔj^{h1}	tuba:ŋ^{1}	taba:ŋ^{1}	tluəŋʔ	cɔ:ŋ	cɔ:ŋ	cɔ:ŋ	*cɔ:ŋ^{4}	ba:ŋ^{1}	ba:ŋ^{1}	ba:ŋ^{1}	va:ŋ^{1}	ba:ŋ^{1}		*ɟɔ:ŋʔ
466	cinq, five	*ɗam	nam^{A1}					dam^{1}	dam^{1}	dam^{1}	dam^{1}	dam^{1}	dam^{1}	dam^{1}	dam	dam	dam	dam	*dam^{1}	dam^{1}	dam^{1}	dam^{1}	ram^{1}	dam^{1}	ram^{1}	
467	crabe, crab	*k-ta:m	za:m^{A1}					kata:m^{1}	kata:m^{1}	ɣim^{2}	kata:m^{1}	sɛ:p^{7}	katə:m^{1}	katə:m^{1}	katʌ:m	ɣa:p	^{h}la:p	^{h}la:p	*ra:p^{8}	k^{h}ru:m^{3}	kua^{1}	kua^{1}	kua^{1}	kua^{1}	kua^{1}	*kua
468	dent, tooth	*k-saŋ	zaŋ^{A1}					kəsaŋ^{1}	kəsaŋ^{1}	kəsaŋ^{1}	kasaŋ^{1}	kasaŋ^{1}	kəsaŋ^{1}	kəsaŋ^{1}	at^{h}aŋ				*knɛ:ŋ^{1}	nɛ:ŋ^{1}		t^{h}aŋ^{1}		saŋ^{1}	saŋ^{1}	
469	deux, two	*ha:r	ha:j^{A1}					ha:l^{1}	ha:r	ha:ɯ^{1}	ha:l^{1}		ha:l^{1}	ha:l^{1}	hæ:l	ha:n	ha:l	ha:l	*ha:l^{1}	ha:l^{1}	ha:n^{1}	ha:l^{1}	ha:ə^{1}	ha:l^{1}	ha:n^{1}	
470	empan, span	*c-ka:ŋ	ɣa:ŋ^{A1}					səka:ŋ^{1}	cika:ŋ^{1}	təka:ŋ^{1}	cika:t^{7}	cika:t^{7}	təka:ŋ^{1}	təka:ŋ^{1}	cikæ:ŋ	ka:ŋ			*tka:ŋ^{1}	ka:ŋ^{1}	ɣa:ŋ^{1}		ka:ŋ^{1}	ka:ŋ^{1}	ka:ŋ^{1}	*c-ka:t
471	os, bone	*tʃ-ʔa:ŋ	sɨəŋ^{A1}	sɨəŋ^{A1}	sɨəŋ^{A1}	sa:ŋ^{A1}		cɐ:ŋ^{2}	càaŋ	sa:ŋ^{2}		kajiɛŋ^{1}	sa:ŋ^{2}	sa:ŋ^{2}	sìəŋ	sɨəŋ	siɛŋ	səŋsiɛŋ	*sɨəŋ^{1}	sɨəŋ^{1}	sɨaŋ^{1}		sɨaŋ^{1}	sɨaŋ^{1}	sɨaŋ^{1}	
472	pousses de bambou comestibles, edible bamboo shoots	*t-ɓaŋ	maŋ^{A1}					baŋ^{1}		təbaŋ^{1}	baŋ^{1}	baŋ^{1}	təbaŋ^{1}	təbaŋ^{1}	aɓaŋ	baŋ	baŋ	baŋ	*baŋ^{1}		maŋ&	baŋ^{1}	vaŋ^{1}	baŋ^{1}	vaŋ^{1}	
473	tresser, tisser, to plait, weave	*ta:ɲ	ɗa:n^{A1}							ta:ɲ^{1}			ta:ɲ^{1}	ta:ɲ^{1}	ta:ɲ		ta:n		*ta:ɲ^{1}	ta:n^{1}	ta:n^{1}	ta:ɲ	ta:ɲ^{1}	ta:ɲ^{1}	da:ɲ^{1}	
474	fonte, smelt	*t-ka:ŋ	ɣa:ŋ^{A1}										ka:ŋ^{1}	ka:ŋ^{1}						ka:ŋ^{1}	ɣa:ŋ^{1}	ka:ŋ^{1}	ɣa:ŋ^{1} S ka:ŋ^{1},		ɣa:ŋ^{1}	
475	questionner, to ask	*ha:ɲ	ha:n^{A1}					ha:ɲ^{1}	ha:ɲ^{1}	ha:ɲ^{1}	ha:n^{1}		ha:ɲ^{1}	ha:ɲ^{1}		ha:ɲ	ha:n		*ha:ɲ^{1}	ha:n^{1}						
476	grotte, cave	*ha:ŋ	ha:ŋ^{A1}						kɘ:p											ha:ŋ^{1}	ha:ŋ^{1}		ha:ŋ^{1} S ha:ŋ^{1},		ha:ŋ^{1}	
477	bambou (Dendrocalamus), bamboo (Dendrocalamus)	*k-ta:ŋ	za:ŋ^{A1}					kata:ŋ		kata:ŋ^{1}										ta:ŋ^{1}	δa:ŋ^{1}	ta:ŋ^{1}	ta:ŋ^{1}			
478	charbon de bois, charcoal	*k-caŋ	t^{h}a:n^{A1}													caŋ	kcaŋ	caŋ	*kcaŋ^{1}							
479	dur, coriace, hard, tough	*k-ta:l	za:j^{A1}													ta:n		ta:l	*kta:l^{1}	ta:l^{1}						
480	manger, to eat	*ʔan	ʔan^{A1}																							
481	anguille, eel	*-la:ɲ	lɨən^{A1}					lɨən^{1}		luon^{1}			lə:ɲ^{1}	lə:ɲ^{1}	nʊŋ	lɨəŋ			*lɨəŋ^{1}	lɨən^{1}	lɨən^{1}	lɨəŋ^{1}	lɨəŋ^{1}	lɨəŋ^{1}	lɨəŋ^{1}	
482	bois, végétal, wood, plant	*s-raŋ	saŋ^{A1}					sireŋ^{2}	sirèŋ		t^{h}èŋ^{2}				cirèŋ	k^{h}laŋ	k^{h}laŋ	k^{h}laŋ	*k^{h}raŋ^{1}			k^{h}aŋ^{1}				
483	branchies, gills	*k-ma:ŋ	ma:ŋ^{A1}							tamə:k^{7}		təkak^{7}	kuma:ŋ^{1}		umæ:ʔ					ma:ŋ^{1}		ma:ŋ^{1}	ma:ŋ^{1}	ma:ŋ^{1}/ba:ŋ^{1}		
484	cent, hundred	*k-lam	tɕam^{A1}							kəlam^{1}			klam^{1}	tlam^{1}	tlam	klam			*klam^{1}	klam^{1}	ʈam^{1}	tlam^{1}	klam^{1}	klam^{1}	ʈam^{1}	
485	homme vir, mâle, man, male	*p-la:l	tɕa:j^{A1}						kʊ:ɲʔ				paku:ɲ^{3}		kʊŋʔ	pla:n	pla:l	pla:l		pla:l^{1}		tɨa^{3}	tɨa^{3}	tɨa^{3}	dɨa^{3}	*ta:ʔ
486	gelée blanche, white frost	*k-ra:ŋ	sɨəŋ^{A1}																		ʂɨəŋ^{1}	k^{h}ɨəŋ^{1}	k^{h}ɨəŋ^{1} S k^{h}ɨəŋ^{1},		k^{h}ɨəŋ^{1}	
487	lune, moon	*ɓ-laŋ	tɕaŋ^{A1}													plɔ:ŋ	plɔ:ŋ	plɔoŋ	*plɔ:ŋ^{2}	plɔŋ^{2}		tlaŋ&	klaŋ^{1}	plaŋ^{1}	ʈaŋ^{1}	*p-lɔ:ŋ
488	rapide, fast	*m-laɲ	ɲɛŋ^{A1}																	læŋ^{1}			ɲaŋ^{1}			
489	plein, full	*ɓ-lam	lam^{A1}													blam	blam	blam	*blam^{1}							
490	cocon, larve, cocoon, larva	*na:ŋ	na:ŋ^{A1}																							

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cố Định	VN Nghi Ân	VN	VN Vinh	Maleng	Maleng Bro	Maleng	Thavung	Thavung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ	Thổ Làng Lỡ	Mường Bi	Mường	Mường Sơn La	Mường	Proto Vietic1

						Diêm Điền		Kha Phong		Mã Liềng		Phon Soung								Cuối Chăm			Hoà Bình		Thanh Hoá	
491	baîller, to yawn	*sŋ-ʔa:p	ŋa:p^{D1}					aha:p^{7} səŋa:p^{7}		aŋa:p^{7}	tahɔ:p^{7}		cəŋa:p^{7}	təŋa:p^{7}	aʔiəp	ŋa:p	sŋa:p	ŋa:p	*sŋa:p^{7}	ŋa:p^{7}	ŋa:p^{7}	ŋa:p^{7}	ŋa:p^{7}	ŋa:p^{7}	ŋa:p^{7}	
492	chanter, to sing	*ha:t	ha:t^{D1}							ha:t^{7}			ha:t^{7}	ha:t^{7}	ahæ:t					ha:t^{7}	ha:t^{7}		ha:t^{7}	ha:t^{7}	ha:t^{7}	
493	corbeau, crow	*kr-ʔa:k	ʔa:k^{D1}					ʔa:k^{7}	krʔa:k^{7}	ʔak?a:k^{7}	kʰəʔa:k^{7}	kaʔa:k^{7}	ʔa:k^{7}	ʔa:k^{7}	ʔɑ:k	ʔakʔa:k	ʔakʔa:k	ʔakʔa:k	*ʔakʔa:k^{7}	ʔa:k^{7}		ʔa:k^{7}	ʔa:k^{7}	ʔa:k^{7}	ʔa:k^{7}	
494	corps, body	*cak	tɕak^{D1}	meŋ^{A2}	miŋ^{A2}	miŋ^{A2}	tɕak^{D1}						cak^{7}		cak^{7}				*to:^{1}	sʌn^{1}		pɔ:k^{8}	pɔ:k^{8}	pɔ:k^{8}	bɔ:k^{8}	*bɔ:k
495	eau, water	*ɗa:k	nɨək^{D1}	na:k^{D1}	nʷa:k^{D1}	nɨək^{D1}	na:k^{D1}	da:k^{7}	da:k^{7}	da:k^{7}	da:k^{7}	da:k^{7}	da:k^{7}	da:k^{7}	dæ:k	da:k	da:k	da:k	*da:k^{7}	da:k^{7}	da:k^{7}	da:k^{7}	ra:k^{7}	da:k^{7}	ra:k^{7}	
496	écoper, assécher (pour pêcher), to bail out, to drain (for fishing)	*ʔa-sa:c	ta:t^{D1}					sa:c^{7}					sa:c^{7}	asa:c^{7}	atʰa:c	sa:c		sa:c	*sa:c^{7}	sa:t^{7}	sa:t^{7}					
497	presser (fruit), essorer, to press (fruit), wring	*pat	vat^{D1}					pat^{7}	pat^{7}	pat^{7}					pat									pat^{7}		
498	sable, sand	*t-ka:c	ka:t^{D1}	ka:t^{D1}	kʷa:j^{A2}	ka:t^{D1}	ɣa:t^{D1}						təka:c^{7}	təka:c^{7}	təka:c	kʰlɛ:	pʰlɛ:	kʰlɛ:	*pʰrɛ:^{3}	kʰra:j^{1}	ɣa:t^{7}	ka:c^{7}	ka:c^{7}	ka:c^{7}		*-rɛh
499	sangsue des bois, landleech	*-pat	vat^{D1}					pale:m^{1}	plẹ:m	pale:m^{1}	palə:m^{1}	palə:m^{1}	pli:m^{1}	pli:m^{1}	tliəm	plɛ:m	ple:m	plaem	*ple:m^{1}	ple:m^{1}		pat^{7}	pat^{7}	pat^{7}	bat^{7}	*ple:m
500	aîné de père/mère, father/mother's elder brother	*pa:k	ɓa:k^{D1}										pu:^{1}						*ʔo:ŋ^{1}	ba:k^{7} / pa:k^{7}	ba:k^{7}	ba:k	ba:k	ba:k	ba:k	
501	arrière petits-enfants, great grandchild	*cat	tɕat^{D1}					cat^{7}		cat^{7}			cat^{7}	cat^{7}						cat^{7}	cat^{7}		tʰo:n^{1} / cat^{7}	cat^{7}	cat^{7}	
502	conduire (à la longe), to lead (w. a tether)	*-tac	zat^{D1}							atak^{7}			tak^{7}	tak^{7}			tak	tak	*tak^{7}				tac^{7}	tac^{7}	dac^{7}	
503	acheter, to buy	*ca:k	tɕa:k^{D1}							ca:k^{7}							ca:k		*ca:k^{7}	ca:k^{7}						
504	barrer (une rivière), to obstruct (a river)	*tap	ɗap^{D1}																	tap^{7}		tap^{7}	tap^{7}	tap^{7}	dap^{7}	
505	désirer, avoir soif, desire, thirsty	*kʰa:t	xa:t^{D1}														kʰa:t	kʰa:t	*kʰa:t^{7}	kʰa:t^{7}	kʰa:t^{7}					
506	porter (sur l'épaule), to carry (on shoulder)	*ɓa:k	va:k^{D1}														ba:k	ba:k	*ba:k^{7}	va:k^{7}	va:k^{7}					
507	récolter, moissonner|to harvest	*-kac	kat^{D1}																							
508	fermer (yeux, bouche), to close (eyes, mouth)	*k-ɲap	ɲap^{D1}					kaɲap^{7}	kaɲap^{7}	kaɲap^{7}	(kaɲi:p^{7}	kaɲi:p^{7}	kaɲap^{7}	kaɲap^{7}	aɲìp	ɲap	kʰɲap^{7}	ɲap	*kɲap^{8}				ɲap^{7}		ɲap^{7}	
509	cire, wax	*k-ra:p	sa:p^{D1}					ţa:p^{7}	kəra:p	kəɣa:p^{7}	kʰala:p^{7}	kʰala:p^{7}	kʰra:p^{7}	sa:p^{7}				kʰla:p	*kʰra:p^{7}	kʰra:p^{7}	ʂa:p^{7}	kʰa:p^{7}	kʰa:p^{7}	kʰa:p^{7}	sa:p^{7}	
510	fer, iron	*k-rac	sat^{D1}							kʰlat^{7}			kʰlat^{7}	ʃat^{7}		lac	kʰlɛk	lac	*kʰrac^{7}	kʰrat^{7}	ʂat^{7}	kʰac^{7}	kʰac^{7}	kʰac^{7}	kʰac^{7}	
511	froid, frais, cold, cool	*t-ma:c	ma:t^{D1}										rəma:c^{1}	təma:c^{1}							ba:t^{7}					
512	paresseux, lazy	*k-ɲa:k	ɲa:k^{D1}													ɲa:k		ɲa:k	*kɲa:k^{7}	ɲa:k^{7}	ɲa:k^{7}			ɲa:k^{7}	ɲa:k^{7}	
513	étaler (natte), to spread (a mat)	*p-la:t	tɕa:j^{c1}													pla:t	pla:t	pla:t	*pla:t^{7}	pa:t^{7}						
514	étaler, exposer au soleil, to spread, expose to sun	*p-ta:s	ta:j^{c2}					pəta:j^{56}	pata:jʔ	ta:ɯ^{h2}	hata:j^{h1}	ata:j^{h1}	ta:r^{h}	ta:l^{h}	tʰè:l		ta:t	ta:c	*ta:c^{7}	ta:l^{5}		ta:j^{5}	ta:j^{5}	fa:j^{5}	da:j^{5}	*p-ra:s
515	gratter, to scratch	*-ka:s	ɣa:j^{c2}	xa:n^{c1}	xɔt^{D1}	ɣa:j^{B2}	xa:j^{c1}		aka:jʔ		aka:j^{h1}	akaj^{h1}						ka:c	*ka:c^{7}	kʰa:l^{5}	kʰa:n^{56}		ka:j^{5}	ka:j^{5}		
516	agiter, remuer (la queue), to shake, wag (the tail)	*vas	vaj^{c1}					kudaj^{56}		vaj^{h}vaj^{h}$_{1}$			avar^{h2}	valval^{h2}						val^{5}	vaj^{56}		van^{5}			

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517	semer (le riz) à la volée, to broadcast (rice)	*vaːs	vaːj^{c2}					vaːj^{56}		vaːɯ^{h2}		vajʰ	vaːl^{6}			vaːc	vaːt	vaːc	*vaːc^{8}	vɐːl^{6}	vaːn^{56}					
518	langue, tongue	*laːs	lɨəj^{c2}	laːn^{c1}	lʷaj^{B2}	nɨəj^{B2}	laːj^{B2}	laːj^{56}	laːjʔ	ləaɯ^{h2}	lajʰ^{1}	lajʰ^{1}	lèarʰ^{2}	lèalʰ^{2}	lìəh	laːc	laːt	laːc	*laːc^{8}	leːl^{6}	laːn^{56}	laːj^{46}	laːj^{6}	laːj$^{4\ 6}$	laːj^{46}	
519	lait, milk	*p-rah	sɨə^{c2}	sɨə^{c2}	sɨə^{c2}	tʰɨə^{B2}	sɨə^{B2}													sɨa^{6}	ʂɨa^{56}	kʰaː^{46}	kʰaː^{6}	faː^{46}		
520	riche, rich	*k-ɟaw	zaw^{A2}	zaw^{A2}	zaːw^{A2}	zaw^{A2}	tɕaw^{A2}	kəcaːw		kəcaːw			kəcèw^{2}	kəcèw^{2}	cèw					jaw^{2}	jaw^{2}					
521	troupeau, essaim, flock, swarm	*baːj	ɓəj^{A2}					peːj^{2}					pèaj^{2}	pèaj^{2}	baj					peːj^{2}						
522	aîné, premier (-né), elder, first (child)	*daːw	ɗəw^{A2}							tèaw			tèaw	tèaw												
523	creuser (un canal), to dig (a ditch)	*daːw	ɗaːw^{A2}					pɨːk^{7}	pɔːk^{7}	pɨːk^{7}			tùːŋ^{2}	tùːŋ^{2}						caː^{5}		taːw^{2}	taːw^{2}	taːw^{2}		*pɨːk
524	épais, thick	*k-daj	zaj^{A2}													taj	ktaj	taj	*ktaj^{2}		ðəaj^{2}	taj^{2}	taj^{2}	taj^{2}	taj^{2}	
525	crête, comb	*maːw	maːw^{A2}					sakɨl^{2}	takɨr^{2}	mpoːŋ^{1}	kapoːl^{3}	apəːl^{3}	kacìːk^{2}	kacìːk^{2}	mbiːl	paoŋ	kpoːŋ	pɔːŋ	*kpoːŋ^{1}		moːŋ^{2}	kɛːl^{2}	maːw^{2}	kɛːl^{2}		*m-ɓiːl
526	Être humain, population (groupe), human, population (group)	*ŋaːj	ŋɨəj^{A2}				ŋaːj^{A2}	məlɛːŋ^{2}	məlɛ̀ːŋ				ŋaːj^{2}	ŋaːj^{2}						(kɨəj^{4}) mɔːl^{2}	ŋaːj^{2}	ŋaːj^{2}	mɔːə^{4}	mɔːl^{4}	mɔːn^{4}	*mɔːlʔ
527	menton, chin	*kaːŋʔ	kamʌ^{A2}					kaːŋ^{3}	kaːŋʔ		kèːŋ^{2}	kèːŋ^{2}							*kaːŋ^{2}	kaːŋ^{3}		kaːŋ^{3}	kaːŋ^{3}	kaːŋ^{3}	kaŋkaːŋ^{3}	
528	faux kapokier (Bombax), kapok tree (Bombax)	*-kaːwʔ	ɣaːw^{B2}																	kaːw^{3}	ɣaːw^{4}		kaːw^{3}	kaːw^{3}		
529	courir, run	*ɟalʔ	tɕaj^{B2}					ajel^{4}	aɟʌlʔ		hatoːŋ^{1}		taŋaj^{3}	aŋaj^{3}		can		cal	*cal^{4}	cal^{4}	can^{4}	cal^{46}	caə^{4}	cal^{46}	can^{46}	*t-ŋajʔ
530	(plante) sauvage, wild (plant)	*-daːlʔ	zaːj^{B2}													taːn		taːl								
531	peu profond, shallow	*gaːnʔ	kaːn^{B2}													kankaːn	kaːn	kankaːn	*kaːn^{4}	keːn^{4}	kaːn^{4}					
532	tordre, essorer, to twist, wring	*vaŋʔ	van^{B2}															vaŋ	*vaŋ^{4}							
533	emprunter, to borrow	*maːŋʔ	mɨən^{B2}	mɨən^{B2}	[mâụ̈]	maːn^{B2}	maːn^{B2}	maːŋ^{3}		məaŋ^{4}			məaŋ^{4}	məaŋ^{4}	maːŋʔ	maːŋ			*maːŋ^{4}	meːn^{4}	mɨən^{4}	maːŋ^{46}	maːŋ^{4}	maːŋ^{46}	maːŋ^{46}	
534	lourd, heavy	*-naŋʔ	naŋ^{B2}					anaŋ^{3}		naŋ^{3}			naŋ^{6}	naŋ^{3}	naŋʔ	naŋ	naŋ	naŋ	*naŋ^{3}	naŋ^{3}	naŋ^{4}	naŋ^{46}	naŋ^{4}	naŋ^{46}	naŋ^{46}	
535	alcool, alcohol	*raːwʔ	zɨəw^{B2}	ziəw^{B2}	zɨəw^{B2}	ziəw^{B2}		kɨn^{3}	kənʔ	kɨn^{3}	kin^{3}	kin^{3}	pədoː^{1}			ɣiɛw	ʰliɛw	ʰliɛw	*riɛw^{4}	riɛw^{4}	ʂiɛw^{4}	raːw^{46}	raːw^{4}	tʰaːw^{46}	raːw^{46}	*kənʔ
536	coupe-coupe, bush-knife	*m-raːʔ	zɨə^{B2}	zɨə^{B2}	zʷa^{B2}	zɨə^{B2}				məɣəa^{4}			mərəa^{4}	mərəa^{4}		pʰlaː		pʰlaː	*pʰraː^{4}	pʰreː^{4}	ʂaː^{4}					
537	plants de repiquage, rice seedlings (for transplanting)	*s-maːʔ	ma^{B2}								səmaː^{3}		maː^{4}	maː^{3}						maː^{3}	maː^{3}	maː^{46}	maː^{4}	maː^{46}	maː^{46}	
538	plonger, to sink	*lanʔ	lan^{B2}					lɐn^{4}		lɐn^{4}			lèn^{4}	lèn^{4}		lan		lan	*lan^{4}	lan^{4}	lan^{4}		lan^{4}	lan^{4}	lan^{4}	
539	chaume, stubble	*raːʔ	za^{B2}																	reː^{4}	ʂaː^{4}		ʐaː^{4}	tʰaː^{4}	ʐaː^{4}	
540	salé, salty	*-maŋʔ	man^{B2}													maŋ	kmɛŋ		*kmaŋ^{4}	mÊŋ^{4}	man^{4}		man^{4}		man^{4}	
541	suc, résine, drogue, sap, resin, drug	*ɲaːʔ	ɲɨə^{B2}	ɲɨə^{B2}	ɲɨə^{B2}	ziŋ^{B1}														ɲɨa^{4}			ɲɨa^{4}			
542	venir, to come	*laːjʔ	laːj^{B2}													laːj	laːj	laːj	*laːj^{4}		teːŋ^{3}		teːŋ^{3}			
543	poulet, chicken	*r-kaː	ɣa^{A2}				ɣa^{A1}	kaː^{1}	kaː^{1}	ukaː^{1}	kaː^{1}	kaː^{1}	təkaː^{1}	təkaː^{1}	lakæː	kaː	kaː	kaː	*kaː^{1}	kaː^{1}	ɣaː^{1}	kaː^{1}	kaː^{1}	kaː^{1}	kaː^{1}	
544	aubergine, eggplant	*gaː	kaʌ^{A2}					cahaːŋ^{1}	cɟrhaːŋ^{1}		hahaːŋ^{1}	ahaːŋ^{1}	kèa^{2}	kèa^{2}		kaː		kaː	*kaː^{2}	keː^{2}	kaː^{2}	kaː^{2}	kaː^{2}	kaː^{2}		*cr-haːŋ
545	iguane, iguana	*daː	ɗaʌ^{A2}																	lɛːn^{2} lɛːn^{2}			ti:^{2} taː^{2}	kəj^{2} daː^{2}		

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546	défense (d'éléphant), (elephant) tusk	*ŋa:	ŋa^{A2}					ŋɐ:^{2}	ŋəà^{2}	kasaŋ^{1}	ŋa:^{2}	ŋa:^{2}	pəlàa^{2}	pəlàa^{2}	pəlìə	ŋa:	ŋa:	ŋa:	*ŋa:^{2}	ŋa:^{2}	ŋɐ:^{2}	ŋa:^{2}	nɛ:ŋ^{3}	ŋa:^{2}		*p-la:
547	vieux, âgé|old (in age)	*k-ra:	za^{A2}				tɕa^{A1}	kəra:^{1}	kəra:^{1}	kɨɣa:^{1}			kumèk^{8}	kamèk^{8}	bəre:				*t^{h}aw	k^{h}ra:^{1}	ʂa:^{1}	k^{h}a:^{2}	k^{h}a:^{1}	k^{h}a:^{2}	k^{h}a:^{2}	
548	maison, house	*ŋa:	ŋa^{A2}					kənɔ:^{3}	krnæ:ʔ | krnɒ:ʔ	kənɔ:^{3}		ʔuh	ŋa:^{2}	ŋa:^{2}		ŋa:	ŋa:	ŋa:	*ŋa:^{2}	ŋɐ:^{2}	ŋa:^{2}	ŋa:^{2}	ŋa:^{2}	ŋa:^{2}	ŋa:^{2}	*k-rn-ɔ:ʔ
549	molaire, molar	*-ha:m	ha:m^{A2}										təŋʔa:m^{1}	ʈaʔa:m^{1}	ʔæ:m					hɐ:m^{2}	ha:m^{2}	ha:m^{2}	ha:m^{2}	ha:m^{2}		*-ʔa:m
550	long, long	*ja:r	za:j^{A2}					jɐ:l^{2}	jɬar	ja:ɯ^{2}			jəal^{2}						(*jon^{1})	(jɔ:n^{1}	juan^{1})	ja:j^{2}	za:j^{2}	za:j^{2}	za:j^{2}	
551	gibbon, gibbon	*k-vaŋ	vɨən^{B2}					kwaŋ^{1}	kwaŋ	kwaŋ^{1}	jo:k^{7}	kəjo:k^{7}	jo:k^{7}	jo:k^{7}	kwaŋ	jaok	kjo:k	jɔ:k	*kjo:k^{7}	jo:k^{8}	vɨən^{4}		vɨən^{4}	(vɨən^{46} / zo:k^{8}) | jo:k^{8}	vɨən^{4}	*k-jo:k
552	sucre de canne, sugarcane	*da:ŋ	ɗɨəŋ^{A2}											dɨəŋ^{2}	dɑ:ŋ^{1}				*dɨəŋ^{2}	dɨəŋ^{2}	da:ŋ^{2}	dɨəŋ^{2}	dɨəŋ^{2}	dɨəŋ^{2}	dɨəŋ^{2}	
553	labourer, charrue, to plough, a plough	*gal	kaj^{A2}							kal^{2}			kèl^{2}	kèl^{2}						kal^{2}	kan^{2}					
554	plat, égal, flat, even	*baŋ	ɓaŋ^{A2}											paŋ^{2}						paŋ^{2}			paŋ^{2} S paŋ^{2},		baŋ^{2}	
555	épervier (filet), casting net	*ɟa:l	tɕa:j^{A2}					cɐ:l^{2}			cəal^{2}					ca:n		ca:l	*ca:l^{2}	cɐ:l^{2}	ca:n^{2}				ca:n^{2}	
556	indigo, indigo	*ɟa:m	tɕa:m^{A2}																	ca:m^{2}	cɐ:m^{2}	ca:m^{2}	ca:m^{2}	ca:m^{2}		
557	groupe, troupeau, essaim, group, herd, swarm	*da:n	ɗa:n^{A2}																				ta:n^{2}	ta:n^{2}		
558	déborder, to overflow	*p-la:ɲ	tɕa:n^{A2}										kla:ɲ^{2}	pla:ɲ^{2}						plɐ:n^{2}	ʈa:n^{2}	tla:n^{2}	kla:n^{2}			
559	grosse mouche, bluebottle fly	*-laŋ	laŋ^{A2}	laŋ^{A2}	kɨə^{B1}	ɲaŋ^{B2}							məlaŋ^{1}	məlaŋ^{1}						bleŋ^{2}		laŋ^{2}				
560	van, winnow	*g-ra:ŋ	sa:ŋ^{A2}										k^{h}ra:ŋ^{1}	sa:ŋ^{1}							ʂa:ŋ^{2}			k^{h}a:ŋ^{2}		
561	aréquier, areca, arecanut, areca	*p-na:ŋ	tɕəw^{A2}	tɕəw^{A2}	tɕu^{A2}	təw^{A2}		pəna:ŋ^{1}	pəna:ŋ^{1}		pəna:ŋ^{1}	pəna:ŋ^{1}										na:ŋ^{1}		na:ŋ^{1}		
562	dix, ten	*ma:l	mɨəj^{A2}													mɨəj^{2}	mɨəj^{2}	ma:l	*ma:l^{2}	mɨəj^{2} et	mɨəj^{2}					
563	caquetter, to cackle	*k-ta:k	kuk^{D2}					kuta:k^{7}		kuta:k^{7}			kuta:k^{7}	kuta:k^{7}	kutæ:k	kata:k	katɔ:k		*kata:k^{7}	kuk^{8} ta:k^{7}			kuk^{8} ta:k^{7}		ta:k^{7}	
564	cracher, to spit" / "crachat, spittle	*kr-ha:k	xa:k^{D2}					kəhe:k^{8}	krha:k	kəha:k^{8}	k^{h}əha:k^{7}		kəha:k^{8}	kəha:k^{8}	kəhè:k	k^{h}a:k	k^{h}a:k	k^{h}a:k	*k^{h}a:k^{8}	k^{h}a:k^{8}		k^{h}a:k^{8}	k^{h}a:k^{8}	k^{h}a:k^{8}	k^{h}a:k^{8}	
565	battre (le riz), écraser du pied, to thresh rice, to crush with the feet	*da:p	ɗa:p^{D2}							tàap^{8}	katè:p^{8}				katæ:p	ta:p		ta:p	*ta:p^{8}	tɐ:p^{8}		ta:p^{8}	ta:p^{8}			
566	lien, corde, link, rope	*ɟa:k	tɕa:k^{D2}										cə̀ak^{8}	cə̀ak^{8}		ca:k	ca:k	ca:k	*ca:k^{8}	cɐ:k^{8}	ca:k^{8}	ca:k^{8}	ca:k^{8}	ca:k^{8}		
567	éventail, fan	*gwa:t	k^{w}a:t^{D2}					səpal^{1}			tapɛn^{1}	tapɛl^{1}		kwa:t^{8}			kwa:t	kwa:t Lkwa:t	*kwa:t^{8}	kwa:t^{8}	kwa:t^{8}	kwa:t^{8}	kwa:t^{8}	kwa:t^{8}	kwa:t^{8}	*s-pal
568	tenir dans les mâchoires, to hold in the mouth	*ga:p	ka:p^{D2}					kɐ:p^{8}	kə̀ap		kɐ:p^{8}	kɐ:p^{8}				ka:p	ka:p	ka:p	*ka:p^{8}	ka:p^{8}						
569	poser, to put	*dac	ɗat^{D2}																	tac^{8}	tac^{8}					
570	se vêtir, to dress	*mak	mak^{D2}					màk^{8}		mɐk^{8}			mèk^{8}	mèk^{8}	mèk	mak	mak	mak	*mak^{8}	mak^{8}	mak^{8}	mak^{8}	mak^{8}	mak^{8}	mak^{8}	

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571	lanières de bambou, strips of bamboo	*la:c	la:t^{D2}						la:c^{8}		la:c^{7}						la:t		*la:c^{8}	le:t^{8}	la:t^{8}		la:t^{8}	la:c^{8}	la:c^{8}	
572	pou des poulets, chicken louse	*ma:c	ma:t^{D2}					səpɛ:^{1}	səpæ:^{1}								ma:t	ma:c	*ma:c^{8}							*s-pɛ:
573	fade, tasteless	*m-la:c	la:t^{D2}					məla:c^{2}								mla:c	mla:t	mla:c	*mla:c^{8}	ble:t^{8}	na:t^{8}					
574	glisser, to slip	*b-la:t	tɕɨət^{D2}													kle:t	kle:t pʰla:t	kli:t	*pla:t^{8}	plə:t^{8}	ʈɨət^{8}	tlɨət^{8}	klɨət^{8}			*g-le:t
575	éplucher, gratter, to peel, scrape	*p-la:k	lot^{D2}													pla:k	pla:k	pla:k	*pla:k^{7}							
576	riz non glutineux, nonglutinous rice	*k-sa:j		tɛ^{c1}	nhaẹng	tɛ^{B2}			càawʔ				loɔ̀ɲ^{2}			sa:j		sa:j	*ksa:j^{1}	cam^{1}		cam^{1}		cam^{1}	cam^{1}	*cam
577	épouse aîné de la mère, moth's elder broth's wife	*-na:j		[mâự]	la^{A2}	mə^{B2}				na:j^{1}			na:j	na:j^{1}												
578	milan, kite	*k-la:ŋʔ		ɗiw^{A2}	ka:j^{B2}	ziəw^{A2}		kəla:ŋ^{3}	kala:ŋʔ	kəla:ŋ^{3}	kəla:ŋ^{3}	kəla:ŋ^{3}	kəla:ŋ^{3}	kəla:ŋ^{3}	kəlæ:ŋʔ	hɛ:n		haɛl	*kla:ŋ^{3}			tla:ŋ^{3}	klɔ:ŋ^{3}	kla:ŋ^{3}	ʈa:ŋ^{3}	*hɛ:l
579	étoffe de coton, cotton cloth	*k-pa:s	va:j^{c1}					kəpa:j^{5}	krdǫ:ʔ	kəpa:ɯ^{h1}	kəpaj^{h1}	kəpaj^{h1}	kupa:l^{6}	kupa:l^{6}	kupɐ:lʔ				*kpa:j^{1}	pa:l^{5}	pa:n^{56}	pa:j^{5}	pa:j^{5}	pa:j^{5}	ba:j^{5}	
580	frapper de la main, gifler, to hit with hand, to slap	*t-pah	va^{c1}					təpa:^{5}	təpa:ʔ	təpah^{1}	təpah^{1}		təpah^{1}	təpah^{1}	mpah					pa:^{5}		pa:^{5}				
	VOWEL *ɔ:																									
581	bec, beak	*k-ɓɔh	mɔ^{c1}							mɔ:^{4}	sanɔ:j^{1}	sano:j^{1}	tubɔc^{7}	cabɔc^{7}	mbɑ:c	bɔ:		bɔ:		bɒ:^{5}	bɔ:^{56}	mɔ:^{5}	mɔ:^{5}	mɔ:^{5}	mɔ:^{5}	*c-ɓɔ:c
582	goutter, to drip	*k-ʃɔh	ɲɔ^{c1}					tʰəɟɔ:^{5}		kəɟɔh^{1}			təɟɔh^{1}	təɟɔh^{1}	ɟɑh							jɔ:^{5}	ɲɔ:^{5}			
583	enfiler, piquer, brochette, to thread, to sting, to skewer	*tʃɔh	sɔ^{c1}					cɔ:^{56}		sɔ:^{3}	hacɔh^{1}		sɔ:^{4}	cɔh^{1}		sɔ:		sɔ:	*sɔ:^{3}	saw^{1}	sɔ:^{56}	sɔ:^{5}		sɔ:j^{46}		
584	herbe, grass	*kɔh	kɔ^{c1}							kɔh^{1}	kɔh^{1}		kɔh^{1}	kɔh^{1}		bat	bat	bat	*bat^{7}	kɒ:^{5}	kɔ:^{56}	kɔ:^{5}	kɔ:^{5}	kɔ:^{5}	kɔ:^{5}	*ɓat
585	rouge, red	*tɔh	ɗɔ^{c1}								tɔh^{1}		tɔh^{1}	tɔ:^{6}		kaon		kɔ:l	*ko:l^{1}		dɔ:^{56}	tɔ:^{5}	tɔ:^{5}	tɔ:^{5}	dɔ:^{5}	*ko:l
586	écorce > coquille, bark > shell	*-pɔh	vɔ^{c1}								kʰăbɔh^{1}	kăbɔh^{1}					kpɔ:	pɔ:		pɒ:^{5}	voa^{56}	pɔ:^{46}	pɔ:^{5}	pɔ:^{5}	bɔ:^{46}		
587	corbeille (grande et plate), basket (large and flat)	*-cɔh	zɔ^{c1}																	kʰrɔ:ŋ^{1}			co:^{5}	cɔ:^{5}			
588	aboyer, to bark	*k-rɔh	suə^{c1}					ʂɔ:^{56}	karua^{5}	kəɣoh^{2}	kaluh^{1}		ʔu:ɲ^{3}	ʔu:ɲ^{3}		kʰlɔ:	kʰlɔ:	kʰlaw	*kʰrɔ:^{4}	kʰrɔ:^{6}	ʂɔ:^{56}		tɛ:^{2}	tɛ:^{2}		*ʔu:ɲʔ
589	ne pas (interdiction), do not (prohibit)	*-nɔh	nɔ^{c1}													nɔ:	nɔ:	nɔ:	*nɔ:^{3}			nɔ:^{5}				
590	fatigué, tired	*-mɔ:s	mɔj^{c1}	ɲɔ:k^{D2}	ɓɛw^{B2}	ɲɔk^{D2}											mɔ:j	mɔ:j	*mɔ:j^{3}				ɲɔ:k^{8}			
591	gravier, gravel	*k-rɔ:s	sɔj^{c1}																	kʰrɔ:j^{5}	ʂɔ:j^{56}		kʰɔ:j^{5} S -,			
592	queue, tail	*tɔ:j	ɗuəj^{A1}	ɗuj^{A1}	ɗuəj^{A1}	ɗuəj^{A1}	toj^{A1}	tɔ:j^{1}	tɔɔj^{2}	tuej^{2}	tɔɔj^{2}	tɔɔj^{2}	tuej^{2}	tuej^{2}	tùəj	tɔ:j	tɔ:j	tɔ:j	*tɔ:j^{2}	tɔ:j^{2}	ðuəj^{2}	tuoj^{1}	tuoj^{1}	tuoj^{1}	duoj^{1}	
593	fouet, whip	*p-rɔ:j	zɔj^{A1}					urɔ:j		ɣɔ:j			brɔ:j^{1}	brɔ:j^{1}	rɔ:j	ɣɔ:j	ʰlɔ:j	ʰlɔ:j	*rɔ:j^{1}	rɔ:j^{1}	ʂɔ:j^{1}	rɔ:j^{1}	rɔ:j^{1}	tʰɔ:j^{1}		
594	banane, banana	*cɔ:jʔ	tɕuəj^{B1}					ɲɔ:ŋ^{3}	ɲɔ:ŋʔ	kădɔ:ʔ		ɲɔ:ŋ^{3}	kătaj^{1}	kataj^{1}	ataj	ca:j	ca:j	ca:j	*ca:j^{3}	ca:j^{3}	ca:j^{3}	cuoj^{3}	cuoj^{3}	cuoj^{3}	cuoj^{3}	*k-taj
595	boire, to drink	*ʔɔ:ŋʔ	ʔuəŋ^{B1}	ʔuŋ^{B1}	ʔuəŋ^{B1}	ʔuəŋ^{B1}		ɲu:^{4}			ɲu:^{3}	ŋu:^{3}	ɲu:^{4}	ɲu:^{4}	ɲù:ʔ	ɲo:	ɲo:	ɲu:	*ɲo:^{4}	ɲo:^{4}	ɲɔ:^{3}	ʔɔ:ŋ^{3}	ʔɔ:ŋ^{3}	ʔɔ:ŋ^{3}	ʔɔ:ŋ^{3}	
596	bouquet, botte, bouquet, bunch	*pɔ:ʔ	ɓɔ^{B1}										pɔ:^{3}	pɔ:^{3}	pɑ:ʔ	pɔ:	pɔ:	pɔ:	*pɔ:^{3}	pæ:^{3}	pɔ:^{3}					
597	chien, dog	*ʔa-cɔ:ʔ	tɕɔ^{B1}					cɔ:^{3}	cɒ:^{3}	cɔ:^{3}	cɔ:^{3}		acɔ:^{3}	acɔ:^{3}	acɑ:ʔ	cɔ:	cɔ:	cɔ:	*cɔ:^{3}	cɒ:^{3}	cɔ:^{3}	cɔ:^{3}	cɔ:^{3}	cɔ:^{3}	cɔ:^{3}	

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598	être, avoir, il y a, to be, to have, there is	*kɔːʔ	kɔ^{B1}					kɔː^{3}		kɔː^{3}			kɔː^{3}	kɔː^{3}	kɑʔ	kɔː	kɔː	kɔː	*kɔː^{3}	kɒː^{3}	kɔː^{3}					
599	fumée, smoke	*k-hɔːjʔ	xɔj^{B1}					kahɔːj^{3}	kahɒːjʔ	kahɔːj^{3}	kəhɔːj^{3}	kəhɔːj^{3}	kəhɔːj^{3}	kəhɔːj^{3}	ahɑːjʔ	kʰɔːj	kʰɔːj	kʰɔːj	*kʰɔːj^{3}	kʰɒːj^{3}	kʰɔːj^{3}	kʰɔːj^{3}	kʰɔːj^{3}	kʰɔːj^{3}	kʰɔːj^{3}	
600	sel, salt	*ɓɔːjʔ	muəj^{B1}	mʷəj^{B1}	mɔj^{B1}	muəj^{B1}	mɔj^{B1}	bɔːj^{3}	bɒːjʔ	bɔːj^{3}	bɔːj^{3}	bɔːj^{3}	bɔːj^{3}	bɔːj^{3}	bɑːjʔ	bɔːj	bɔːj	bɔːj	*bɔːj^{3}	bɒːj^{3}	bɔːj^{3}	bɔːj^{3}	vɔːj^{3}	bɔːj^{3}	vɔːj^{3}	
601	vent, wind	*k-jɔːʔ	zɔ^{B1}					kəjɔː^{3}	kajɒːʔ	kəjɔː^{3}	kəjuː^{3}	kajuː^{3}	kəjɔː^{3}	kəjɔː^{3}	kajɑːʔ	jɔː	kəjɔː	jɔː	*kjɔː^{3}	sɒː^{3}	jua^{3}	sɔː^{3}	sɔː^{3}	sɔː^{3}	sɔː^{3}	
602	ombre, shadow	*pɔːŋʔ	ɓɔŋ^{B1}										pɔːŋ^{3}							pɒːŋ^{3}	pɔːŋ^{3}		pɔːŋ^{3}	pɔːŋ^{3}	bɔːŋ^{3}	
603	chapeau conique, conical hat	*ɗɔːnʔ	nɔn^{B1}					dɔːn^{3}		nɔːn^{3}									*nɔːn^{3}		nɔːn^{3}	dɔːn^{3}	nɔːn^{3}	dɔːn^{3}		
604	crier (animaux), meugler, cry (of animal), moo	*ʔɔːʔ	ʔɔ^{B1}					ʔɔː^{3} / jeːɲ^{3}		ʔɔː^{3}	atɛːl^{3} / atɛːn^{3}									taːl^{3}	ʔoː^{56}					*-tɛːlʔ
605	vessie, bladder	*pɔːŋʔ	ɓɔŋ^{B1}					bɔŋbɔːŋ^{3}		pɔŋpɔːŋ^{3}	hapuŋ^{3}	apuŋ					puŋpuːŋ	pɔːŋ	*pɔːŋ^{3}		bɔŋ^{3} bɔːŋ^{3}	pɔːŋ^{2} pɔːŋ^{3}	bɔŋbɔːŋ^{3}	pɔŋpɔːŋ^{3}		
606	descendre, to go down	*tʃɔːŋʔ	suəŋ^{B1}	suəŋ^{B1}	suəŋ^{B1}	suəŋ^{B1}														cɔːŋ^{4}	joaŋ^{4}		suoŋ^{3}		suoŋ^{3}	
607	liseron d'eau (Ipomea x), water spinach (Ipomoea x)	*ɓɔːŋʔ	muəŋ^{B1}	muŋ^{B1}	muəŋ^{B1}	muəŋ^{B1}														muoŋ^{3}	muoŋ^{3}			bɔːŋ^{3}	vɔːŋ^{3}	
608	bout, extrémité > tétine, end, extremity > nipple	*kɔːjʔ	kuəj^{B1}													kɔːj		kɔːj	*kɔːj^{4}	kɔːj^{4}						
609	difficile, difficult	*kʰɔːʔ	xɔ^{B1}													kʰɔː	kʰɔː	kʰɔː	*kʰɔː^{3}	kʰɔː^{3}	kʰɔː^{3}					
610	nasse, trap	*tɔːʔ	ɗɔ^{B1}													tɔː	tɔː	tɔː	*tɔː^{3}							
611	vinaigre, acide, vinegar, acid" "âpre, bitter	*ɟɔːʔ	tɕuə^{A1}					coɔ^{4}	còɔʔ																	
612	ligoter, to bind	*k-lɔːjʔ	tɕɔj^{B1}					kəlɔːj^{3}		kəlɔːj^{3}			klɔːj^{3}	tlɔːj^{3}	tlɑːjʔ					klɒːj^{3}	ʈɔːj^{3}	tlɔːj^{3}	klɔːj^{3}	klɔːj^{3}		
613	loup, wolf	*k-rɔːrʔ	sɔj^{B1}					ʈɔːl^{4}		kəlɔːɯ^{3}	kəlɔːn^{3}	kəlɔːl^{3}	krɔːl^{3}	tlɔːl^{3}	kərɑːlʔ	klɔːn	klɔːl	klɔːl	*klɔːl^{3}	klɒːl^{3}	ʂɔːj^{3}	kʰɔːl^{3}	kʰɔːəˀ^{3}	kʰɔːl^{3}		
614	ongle, sabot, griffe, nail, hoof, claw	*-mɔːŋʔ	mɔŋ^{B1}										katoːŋ^{1}	katoːŋ^{1} | mɔːŋ^{3}	katɔːŋ						mɔːŋ^{3}	mɔːŋ^{3}	mɔːŋ^{3}	mɔːŋ^{3}	mɔːŋ^{3}	*k-toːŋ
615	riz paddy, paddy rice	*ʔa-lɔːʔ	luə^{B1}	lɔ^{B2}	lɔ^{B1}	nuə^{B1}	lɔ^{B1}			ulɔː^{3}	alɔː^{3}		alɔː^{3}	alɔː^{3}	alɑːʔ	lɔː		law	*lɔː^{4}	lɔː^{4}	lua^{3}	lɔː^{46}	lɔː^{3}	lɔː^{46}	lɔː^{46}	
616	chauve, crane rasé, bald-headed, shaved head	*k-rɔːlʔ	sɔj^{B1}					kuruːl^{4}			kaleːn^{4}	kaleːl^{4}	klɔːl^{3}	sɔːl^{3}		kɔnlɔːn	klɔːl	klɔːl		ləːl^{3}		lɔːl^{46}	lɔːə^{4}			*k-laːlʔ
617	doigt, finger	*-ŋɔːnʔ	ŋɔn^{B1}					kadɔːj^{3}	kudɒːjʔ	kudɔːj^{3}	kadɔːj^{3}	kadɔːj^{3}		kuveː		dɔːj	dɔːj	dɔːj	*dɔːj^{3}	dɒːj^{3}	ŋɔːn^{3}	ŋɔːn^{3}	ŋɔːn^{3}	ŋɔːn^{3}	ŋɔːn^{3}	*k-ɗɔːjʔ
618	entre-noeud, phalange, inter-node, phalanx	*p-lɔːŋʔ	lɔŋ^{B1}	ʔuəŋ^{B1}	laŋ^{B1}	ɗot^{D1}	lɔŋ^{B1}	pəlɔːŋ^{3}			pəlɔːŋ^{3}					plɔːŋ	plɔːŋ	plɔːŋ	*plɔːŋ^{3}		ʈɔːŋ^{3}		plɔːŋ^{3}	plɔːŋ^{3}		
619	cime, extrémité, tip, end	*ŋɔːnʔ	ŋɔn^{B2}							kɔːɲ^{3}										kɔːj^{4}	ŋɔːn^{4}		ŋɔːn^{4}	ŋɔːn^{46}	ŋɔːn^{4}	
620	édenté, toothless	*-mɔːmʔ	mɔm^{B1}																	bɒːp^{7}	mɔːm^{3}		mɔːm^{3}	mɔːm^{3}		
621	rassasié, satiated	*ɗɔː	nɔ^{A1}							dɔː^{1}			dɔː^{1}	dɔː^{1}	ɗɑː	dɔː	dɔː	dɔː	*dɔː^{1}	dɒː^{1}	dɔː^{1}	dɔː^{1}	ðɔː^{1}	dɔː^{1}	rɔː^{1}	
622	mesurer, to measure	*tɔː	ɗɔ^{A1}					tɔː^{1}	tɒː	tɔː^{1}	tʰɛːk^{8}		tɔː^{1}	tɔː^{1}						tɒː^{1}	dɔː^{1}			tɔː^{1}		
623	abeille maçonne, mason bee	*p-tɔː	ʔɔŋ^{A1}					pətɔː^{1}		pətɔː^{1}								tətɔː	*ktɔː^{1}			tɔː^{1}	tɔː^{1}	tɔː^{1}		
624	tousser, to cough	*hɔː	hɔ^{A1}													hɔː	hɔː	hɔː	*hɔː^{1}		hɔː^{1}					
625	fourreau, sheath	*pɔː	ɓaːw^{A1}	ɓəjˀ^{A2}	[bôu]	ɓaːw^{A1}												pɔː	*pɔː^{1}							
626	cendres, ashes	*p-lɔː	tɕɔ^{A1}				muɲ^{A1}	buːɲ^{1}	bʊːɲ		buːn^{1}	buːɲ^{1}			bʊːɲ	buːɲ	buːn	buːɲ	*buːɲ^{1}	plɒː^{1}	ʈɔː^{1}	buːɲ^{1}	puːɲ^{1}	buːɲ^{1}	vuːɲ^{1}	*ɓuːɲ
627	(feuilles à) couvrir, cover (with leaves)	*k-lɔː	tɕɔ^{A1}																*klɔː^{1}	klɒː^{1}	ʈɔː^{1}					

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628	fils, fille, générique de personne, son, daughter, generic person	*kɔ:n	kɔn^{A1}				kɔn^{A1}		kadɒ:ʔ		kɔ:n^{1}	kɔ:n^{1}	kɔ:n^{1}	kɔ:n^{1}		kɔ:n	kɔ:n	kɔ:n	*kɔ:n^{1}	kɒ:n^{1}	kɔ:n^{1}	kɔ:n^{1}	kɔ:n^{1}	kɔ:n^{1}	kɔ:n^{1}	
629	jeune, tendre, young, tender	*k-n-ɔ:n	nɔn^{A1}					kənɔ:n^{1}					katə:ŋ^{3}	katə:ŋ^{3}		nɔ:n		nɔ:n	*nɔ:n^{1}	dɛ:t^{7}		nɔ:n^{1}	nɔ:n^{1}	nɔ:n^{1}	nɔ:n^{1}	*k-tə:ŋʔ
630	(tirer) juste, (to shoot) true	*dɔ:ŋ	tɕuŋ^{B1}													tɔ:ŋ	tɔ:ŋ	tɔoŋ	*tɔ:ŋ^{2}				duŋ^{3})			
631	jonc, rush	*k-rɔ:ŋ	sɔŋ^{A1}					kərɔ:ŋ^{1}		kəɣɔ:ŋ^{1}	x S -,		kərɔ:ŋ^{1}	ʈɔ:ŋ^{1}	karɑ:ŋ											
632	clair, limpide, clear, limpid	*k-lɔ:ŋ	tɕɔŋ^{A1}													klɔ:ŋ		klɔ:ŋ	*klɔ:ŋ^{1}		ʈɔ:ŋ^{1}		klɔ:ŋ^{1}	klɔ:ŋ^{1}		
633	arracher, récolter, pull out, gather	*pɔ:c	ɲo^{c1}						upʌc						upʊ:c									pɔ:c^{7}		
634	cerveau, brain	*c-ʔɔ:k	ʔɔk^{D1}					ʔɔ:ŋ^{3}	ʔɒ:ŋʔ	ʔɔ:ŋ^{3}			cəʔɔ:k^{7}	cəʔɔ:k^{7} | taʔɔ:ŋ^{3}						ʔɒ:k^{7}	ʔɔ:k^{7}	ʔɔ:k^{7}	ʔɔ:k^{7}			*t-ʔɔ:ŋʔ
635	macérer, macerate	*pɔ:p	ʔɨəp^{D1}											pɔ:p^{7}						pɒ:p^{7}						
636	affûter, émincer, to grind, chop	*pɔ:c	vɔt^{D1}																			pɔ:c^{7}	pɔ:c^{7}	pɔ:c^{7}		
637	avaler, to swallow	*dɔ:c	nuət^{D1}	nʷət^{D1}	nɔt^{D1}	nuət^{D1}										dɔ:c	dɔ:t	dɔ:c	*dɔ:c^{7}	du:t	dɔ:t^{7}					
638	crapaud, toad	*-rɔk	kɔk^{D1}					urɔk^{7}	rɒk		hɔk^{7}	ʰlɔk^{7}	atù:t^{8}	atù:t	utù:t	ɣok-ɣo:k		ʰlok-ʰlo:k	*ro:k^{8}	rɛkrɛ:k^{8} rek-re:k^{8}			ra:k^{8}	tʰa:k^{8}		*ro:k
639	écureuil, squirrel	*p-rɔ:k	sɔk^{D1}					kujɔ:t^{8}	kujòɔt	kujuot^{8}			camo:k^{7}	tumo:k^{7}	pərɑ:k	pʰlɔ:k	pʰlɔ:k	pʰlɔ:k	*pʰrɔ:k^{7}	tɔ:l^{3}	ʂawk^{7}	cuot^{8}	cuot^{8}	chuot^{8}		*to:lʔ
640	balai, broom	*tʃ-nɔ:k	nuək^{D1}													nɔ:k			*snɔ:k^{7}	(ke:^{3}) sɔ:k^{8}	noak^{8}			sɔ:k^{7}		
641	brouillard, fog	*k-mɔ:k	mɔk^{D1}													mɔ:k	kʰmɔ:k	mɔwk	*kmɔ:k^{8}	mɒ:k^{7}						
642	remplir, to fill up	*-rɔ:c	zɔt^{D1}													ɣɔ:c		ʰlɔ:c	*rɔ:c^{7}							
643	disette, scarcity	*-ŋɔ:t	ŋɔt^{D1}														ŋɔ:t	ŋɔ:t	*ŋɔ:t^{8}							
644	balayer, to sweep	*dʒɔ:k	suək^{D1}															sɔ:k	*sɔ:k^{7}							
645	moustique, mouche, mosquito, fly	*mɔ:s	muəj^{c2}	mɔn^{c1}	mɔj^{B2}	muəj^{B2}		mɔ:j^{56}	mɒ:jʔ				ke:p^{7}	so:l^{3}					*ŋo:ŋ	mɔ:l^{6}	muoj^{4}	mɔ:j^{56}	mɔ:j^{6}	mɔ:j^{56} et	mɔ:j^{56}	
646	éléphant, elephant	*-vɔ:j	vɔj^{A1}					ɟɨ:^{3}	ɟəːʔ			jo:^{3}	acàaŋ^{2}	acàaŋ^{2}	acìəŋ	vɔ:j	vɔ:j	vɔ:j	*vɔ:j^{1}	vɒ:j^{1}	vɔ:j^{1}	wɔ:j^{1}	vɔ:j^{1}	vɔ:j^{1}	vɔ:j^{1}	*ʃɟɨ:ʔ
647	trompe (d'éléphant), (elephant) trunk	*vɔ:j	vɔj^{A2}							vɔ:j^{2}			vɔ:j^{2}	vɔ:j^{2}	vɔ̀:j^{2}					vɔ:j^{2}	vɔ:j^{2}	wɔ:j^{2}	vɔ:j^{2}	vɔ:j^{2}	vɔ:j^{2}	
648	mouche, fly	*m-rɔ:j	zuəj^{A2}	zɔj^{A2}	zɔj^{A2}	zuəj^{A2}	zɔj^{A2}	mərɔ:j^{1}	murɔ:j^{1}		mɔj^{h1}	mɔj^{h1}	pərɔ:j^{2}	pərɔ:j^{2}	urùəj	ɣɔ:j	ʰlɔ:j	ʰlo:j	*rɔ:j^{2}	rɔ:j^{2}		ruəj^{2}	ruəj^{2}	tʰuəj^{2}	ruəj^{2}	
649	asticot, maggot	*k-rɔ:j	zɔj^{A2}									tih				cɔ:j			*cɔ:j^{1}	kʰrɒ:j^{1}	sɔ:j^{1}	kʰɔ:j^{2}	kʰɔ:j^{2}	kʰɔ:j^{2}		
650	pinces (de crabe), (crab) pincers	*kɔ:ŋʔ	kɔŋ^{A2}					kɔŋkɔ:ŋ^{3}	kɔŋkɒ:ŋʔ				kɔ:ŋ^{4}	kɔ:ŋ^{4}	ŋkɒŋʔ		ŋɔ:ŋ		*ŋɔ:ŋ^{2}	ŋa:ŋ^{2}	ka:ŋ^{2}	ka:ŋ^{2}	ka:ŋ^{2}	ka:ŋ^{2}		*ŋa:ŋ
651	gorge, gosier, throat, gullet	*-hɔ:ŋʔ	hɔŋ^{B2}					karɔ̀:ŋ^{4}	karɔ̀:ŋʔ	kəɣɔ:ŋ^{4}			knrɔ̀ɔŋ^{4}	kurɔ̀ɔŋ^{4}						hɔ:ŋ^{4}	hɔ:ŋ^{4}		hɔ:ŋ^{4}	kʰɔ:ŋ^{46}		*k-rɔ:ŋʔ
652	cime, extrémité, cyme, tip, end, xxx	*kɔ:ɲʔ	kɔŋ^{B2}					kɔ:ɲ^{3}	kɔ:ɲʔ	kɔ:ɲ^{3}										kɔ:j^{4}	ŋɔ:n^{4}		ŋɔ:n^{4}	ŋɔ:n^{46}	ŋɔ:n^{4}	
653	cage à poule, hen cage	*k-ɗɔ:ŋʔ	tɕuəŋ^{A2}													dɔ:ŋ	kdɔ:ŋ		*kdɔ:ŋ^{3}							
654	crâne, skull	*k-rɔ:ʔ	sɔ^{B2}											caʔɔ:k^{7}	tluəʔ	lɔlɔ:	kʰlɔ:	lɔlɔ:		kʰrɔ:^{4}	sɔ:^{4}					
655	teindre, laquer (les dents), to dye, lacquer (teeth)	*ɲɔ:mʔ	ɲuəm^{B2}					ɲu:m^{4}				ɲɔ:m^{4}	katap^{7}	katap^{7}	ɲù:mʔ	ɲɔ:m	ɲɔ:m	ɲɔ:m	*ɲɔ:m^{4}	ɲə:m^{4}	ɲuom^{4}	ɲuom^{4}	ɲuom^{4}	ɲuom^{4}	ɲuom^{4}	*k-tap

No.	GLOSS	Proto Vietic	VN Hanoi	VN Cổ Định	VN Nghi Ân	VN Diêm Điền	VN Vinh	Maleng Kha Phong	Maleng Bro	Maleng Mã Liềng	Thavung	Thavung Phon Soung	Chứt Rục	Chứt Sách	Arem	Pong Liha	Pong Phong	Pong Toum	proto Pong	Thổ Cuối Chăm	Thổ Làng Lỡ	Mường Bi	Mường Hoà Bình	Mường Sơn La	Mường Thanh Hoá	Proto Vietic1
656	rizière humide, wet rice	*rɔ:ŋʔ	zuəŋ^{B2}	zuəŋ^{B2}	z^{w}aŋ^{B2}	zuəŋ^{B2}		rɔ:ŋ^{4}	rɔ̀:ŋ^{4}	ɣɔ:ŋ^{4}			rùoŋ^{4}	rɔ:ŋ^{4},		ɣɔ:ŋ	^{h}lɔ:ŋ	^{h}lɔoŋ		rɔ:ŋ^{4}	ʂɔ:ŋ^{4}	rɔ:ŋ^{46}	rɔ:ŋ^{4}	t^{h}ɔ:ŋ^{46}	rɔ:ŋ^{4}	
657	suie, soot	*m-lɔ:ʔ	ɲɔ^{B2}													mlɔ:		mlaw	*mlɔ:^{4}	mɔ:l^{4}	lɔ:^{4}					
658	zébu, bovin, zebu, bovine	*bɔ:	ɓɔ^{A2}					pɔ:^{2}		pɔ:^{2}			bɔ:^{2}	bɔ:^{2}	bɔ:^{2}	pɔ:		paw	*pɔ:^{2}	pɔ:^{2}	voa^{2}	pɔ:^{2}	pɔ:^{2}	pɔ:^{2}	bɔ:^{2}	
659	ramper (chenille), glisser, to crawl (caterpillar), to drag	*bɔ:	ɓɔ^{A2}											pɔ:^{2}					*bɔ:^{1}	bɔ:^{2}			pɔ:^{2}	pɔ:^{2}		
660	pattes, legs (of animals)	*-ɟɔ:	zɔ^{A2}																			cɔ:^{2}		cɔ:^{2}		
661	jarre, jar	*vɔ:	vɔ^{A2}													vɔ:		vaw	*vɔ:^{2}				tɔ:ŋ^{3}	tɔ:ŋ^{3}		*tɔ:ŋʔ
662	tortue, tortoise	*ʔa-rɔ:	zuə^{A2}	zuə^{A2}	zuə^{A2}	zuə^{A2}	zɔ^{A2}	ʐɔ:^{1}	rɔ̀:	ɣuo^{2}	hɔ:^{1}	^{h}lɔ:^{1}	arɔ:^{1}	arɔ:^{1}	arɑ:	ɣɔ:	^{h}lɔ:	^{h}law	*rɔ:^{2}	rɔ:^{2}	ʐua^{2}	rɔ:^{2}	rua^{2}	t^{h}ɔ:^{2}	rɔ:^{2}	
663	régime (de banane), bunch (of bananas)	*bɔ:ŋ	ɓuəŋ^{A2}					kərɔ:ŋ^{2}		kənuoŋ^{2}			pɔ̀ɔŋ^{2}	pɔ̀ɔŋ^{2}		puaŋ^{2}				klo:k^{8}	vuoŋ^{2}		puoŋ^{2}	klok^{8}		*g-lo:k
664	(riz) non glutineux, nonglutinous (rice)	*lɔ:ɲ	lɔn^{A2}							lùoɲ^{2}			lòɔɲ^{2}	lòɔɲ^{2}	lò:n			lɔ:n				lɔ:ɲ^{2}				
665	rond, pleine (lune), round, full (moon)	*g-lɔ:n	tɕɔn^{A2}					kəlo:n^{2}		kəlɔ:n^{2}				tlɔ:n^{2}	tlò:n					klɔ:n^{2}	ʐoan^{2}		klɔ:n^{2}	klɔ:n^{2}	ʈɔ:n^{2}	
666	tailler, ciseler, to carve, chisel	*t-kɔ:c	ɣɔt^{D2}	xɔt^{D1}	ɗə:n^{B1}	ɣɔt^{D2}	xɔt^{D1}	kɔ:c^{7}	kɒ:c	kɔ:c^{7}			tuk^{8}	kɔ:c^{7}	kɑ:c		kʰɔ:t^{8}		*tuk^{8}	kɒ:t^{7}	ɣoat^{8}	kɔ:t^{8}		kɔ:t^{8}		*du:k
667	écume, foam	*bɔ:t	ɓɔt^{D2}													pɔtpɔ:t	pɔtpɔ:t	pɔtpɔ:t	*pɔ:t^{8}	pɔ:t^{8}	vɔ:t^{8}	pɔ:t^{8}	pɔ:t^{8}	pɔ:t^{8}		
668	blanc, white	*t-lɔ:k	ɓa:k^{D2}					lɔ:k^{7}			lɔ:k^{1} / p^{h}alu:k^{8}		pəloɔ̀k^{8}	pa:k^{8}	tlùək / tlɑ:k	pa:k | plɔ:k	pa:k plɔ:k	pa:k | plɔwk	*pa:k^{8}	(pɐ:k^{8}) / plɔ:k^{8}		lɔ:k^{8}	lɔ:k^{8}	lɔ:k^{8}		*ba:k
669	doux (au goût), sweet	*t-ŋɔ:c	ŋɔt^{D2}										təŋɔ:c^{7}	təŋɔ:c^{7}	ŋɑ:c	ŋɔ:c	ŋɔ:t	ŋɔ:c	*ŋɔ:c^{8}	ŋɔ:t^{8}	ŋɔ:t^{8}		ŋɔ:c^{8}	ŋɔ:c^{8}	ŋɔ:c^{8}	
670	intestins, intestines	*rɔ:c	zuət^{D2}	zɔt^{D2}	zɔt^{D2}	zuət^{D2}	zɔt^{D2}	rɔ:c^{8}	rɔ̀:c	ɣɔ:c^{8}	hɔ:c	^{h}lɔ:c	ruoc^{8}	ruoc^{8}	rùəc	^{h}lɔ:t	^{h}lɔ:t	^{h}lɔ:c	*rɔ:c^{8}	rɔ:t^{8}	ʂɔ:t^{8}	rɔ:c^{8}	rɔ:c^{8}	t^{h}ɔ:c^{8} rɔ:c^{8},		
671	dard, venin, stinger (of insect), venom	*nɔ:k	nɔk^{D2}						cèr				lèɛl^{2}	lèɛl^{2}						nɔ:k^{8}	nɔ:k^{8}		nɔ:k^{8}	klɛ:^{3}		*lɛ:l
672	bec, beak	*k-ɓɔh	mɔ^{c1}							mɔ:^{4}	sanɔ:j^{1}	sanɔ:j^{1}	tubɔc^{7}	cabɔc^{7}	mbɑ:c	bɔ:		bɔ:		bɒ:^{5}	bɔ:^{56}	mɔ:^{5}	mɔ:^{5}	mɔ:^{5}	mɔ:^{5}	*c-ɓɔ:c
673	goutter, to drip	*k-ʃɔh	ɲɔ^{c1}					t^{h}əɟɔ:^{5}		kəɟɔh^{1}			təɟɔh^{1}	təɟɔh^{1}	ɟɑh							jɔ:^{5}	ɲɔ:^{5}			