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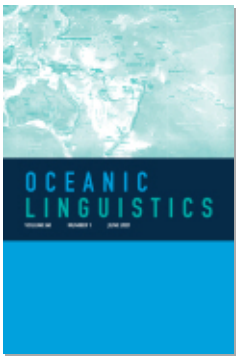

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Hliboi Bidayuh is spoken in the West Kalimantan province of Indonesia, on the island of Borneo. It is part of the larger Land Dayak subgroup, with member languages on both sides of the Malaysia–Indonesia border. Hliboi has several phonological features that warrant focused attention. For example, Hliboi contains geminate consonants in word-initial position, but not in other positions and a restriction on geminate voicing that appears to run counter to typological implications; geminates must be voiced, never voiceless. Hliboi also reflects interesting sound changes that it shares with several other languages of Borneo with "busy" historical phonologies, including the destressing and reduction of penultimate syllables, syllable complexification, and vowel breaking processes that have arisen in now-stressed word-final syllables. In this study, the historical and synchronic phonologies of Hliboi are discussed in detail. The preference for voiced over voiceless geminates is hypothesized to be due to their word-initial only restriction, where perceptual pressures favor voiced over voiceless segments. The historical changes that gave rise to Hliboi's phonology are ultimately rooted in stress shift, a feature that it shares with other languages of the Central Bornean Linguistic Area.

Keywords: Borneo; Historical; Phonology; Bidayuh; Gemination

1. INTRODUCTION. Hliboi is a Bidayuh (Austronesian [AN]; Land Dayak [LD]) language spoken in Lhi Bui town, Siding district, Bengkayang Regency, West Kalimantan, Indonesia, and has not yet been described in any detail in the published linguistic literature.[1] Hliboi is discussed in Smith (2017b) with reference to the Central Bornean Linguistic Area, and again in Smith (2019) as part of a reconstruction of Proto-Land Dayak (PLD), but never as the focus of study. Like many Bidayuh languages, Hliboi has undergone sound changes that have resulted in typologically unexpected features in its synchronic phonology. Chief among these is the presence of geminate consonants in

1. Various spellings exist of the village. Hliboi was suggested by my language consultant, and I have followed his suggestion when referring to the language. Lhi Bui is the Indonesian spelling, and at least one other person from the village has suggested Hlibeui. Special thanks to Subandi, who graciously provided the Hliboi data found in this paper, and to two anonymous reviewers whose comments helped improve upon an earlier draft of this paper. Any mistakes are of course my responsibility.

word-initial, but not other, positions, and the restriction of geminates to voiced segments only. Other phonological features of Hliboi are maximally complex syllables of the shape CCCVCC and both monosyllabic and sesquisyllabic canonical word shapes.

From an AN perspective, the synchronic phonological grammar of Hliboi is far removed from the reconstructed phonology of Proto-Malayo-Polynesian (PMP). This paper, therefore, focuses on describing both the synchronic and diachronic aspects of Hliboi phonology. It discusses both the phonological motivations for observed phonological phenomena and also provides a historical analysis that explains the processes which led to Hliboi's synchronic phonology.

The study first discusses Hliboi's linguistic position as a member of the Bidayuh subgroup of LD. Evidence is discussed regarding Hliboi's specific position within Bidayuh, and evidence for the subgrouping is listed in the appendices. Next, in section 3, the basics of Hliboi's phonology are discussed. Special attention is paid to syllable and word shape, the presence of geminate consonants in initial position, as well as the restriction that geminate consonants must be voiced, and the vowel breaking patterns that occur in final-syllable vowels. Afterward, in section 4, the historical phonology of Hliboi is analyzed. It is shown how the synchronic phonology, including highly altered syllable and word-shapes, geminates, voiceless sonorants, and others, arose through sound change associated with the destressing of penultimate syllables followed by unstressed vowel deletion. Section 5 discusses the relative chronology of these changes.

2. THE LINGUISTIC POSITION OF HLIBOI. Hliboi (ISO 639-3 code sne, which includes all Bau isolects, not just Hliboi) is a Bidayuh language, which belongs to the LD subgroup, part of the larger Malayo-Polynesian subgroup of AN (Smith 2017a). The current higher-level subgrouping for LD is presented in table 1, with Hliboi's member subgroup, Bidayuh, in bold. This is based on Smith (2017a) which proposed a primary division between Benyadu-Bekati' and Bidayuh-Southern LD.[2]

TABLE 1. LD SUBGROUPS.

LAND DAYAK
1. Benyadu-Bekati'
2. Bidayuh-Southern Land Dayak
a. Bidayuh
b. Southern Land Dayak

2. Benyadu-Bekati' consists of Benyadu [byd], Bekati' (Rara [Ira], Sara [Sre], and Lara [Ira] varieties), as well as Mali and Be Aye (Smith and Sommerlot 2020), and Southern LD of Jangkang [djo], Ribun [rir], Golik, Sanggau [scg], and Kembayan (among others).

TABLE 2. BIDAYUH INTERNAL SUBGROUPING.

BIDAYUH
1. Bau-Jagoi-Biatah
a. Bau-Jagoi
Hliboi
b. Biatah
2. Bukar-Sadong

The Bidayuh subgroup is conventionally divided into three groups: Bau-Jagoi, Biatah, and Bukar-Sadong.[3] Lhi Bui town, where Hliboi is spoken, is geographically adjacent to the Bau-Jagoi area, and a preliminary investigation supports the hypothesis that Hliboi indeed subgroups with Bau-Jagoi languages. Furthermore, there may be an argument that Bau-Jagoi and Biatah form a Bau-Jagoi-Biatah subgroup, as shown in table 2. The evidence includes regular and irregular phonological change and exclusively shared lexical replacement innovations.

Regarding the Bau-Jagoi-Biatah group, the phonological evidence is the reduction of nasal + voiceless obstruent clusters via nasal deletion, *NT > T. Such NT clusters are retained in all other LD subgroups. Irregular sound changes that define this group are the deletion of PMP *z in reflexes of *zalan ‘road’ and the fronting of PMP *a (to *e*, and in some languages eventually to *i*) in reflexes of *ikan ‘fish’. Both of these irregular changes are reflected throughout Bau-Jagoi-Biatah but are absent in Bukar-Sadong and the other LD languages. Exclusively shared lexical replacement innovations include Bau-Jagoi-Biatah *arəʔ ‘forehead’, *kajit ‘ear’, *siʔen ‘to cry’, and *(u)tos ‘needle’.

The evidence that Hliboi subgroups specifically with the Bau-Jagoi group is slight but includes the assimilation of *u to a in reflexes of PMP *uRat ‘vein’ (Proto-Bau-Jagoi *ahat) and the lexical replacement innovation *kəjit ‘to listen; to hear’. The linguistic data supporting all of these innovations are listed in the appendix.

3. THE BASICS OF HLIBOI SYNCHRONIC PHONOLOGY. In this section, the essentials of Hliboi’s synchronic phonology are discussed. Basic phonology, such as the consonant and vowel inventories, will be explained, as well as the phonotactics of syllable shape, onset and coda complexity, and the nature of geminate consonants.

3. Rensch et al. (2012) argues for these divisions. An incomplete list of languages in each division is as follows: Bau-Jagoi (Bau, Jagoi, Stungkor, Serasot, Krokong, Stass, Grogo, Peninjau, Gumbang, Apar, Daun), Biatah (Kuap, Giam, Sitaang, Benuk, Bengoh, Padawan, Kiding, Sepug, Gaya, Anah Rais, Sembaan, Tringgus), Bukar-Sadong (Sejijak, Tebakang, Mayang Kawan, Bunan Gega, Mujat, Terbat, Rayang, Ta’ee).

3.1. CONSONANTS. Except for the presence of voiceless sonorants, Hliboi has a typical consonant inventory for an AN language of island Southeast Asia. The stops occur at labial, alveolar, palatal, velar, and glottal places of articulation. There is a length distinction between at least seven of the consonants. The voiced palatal *j* was pronounced more like a full stop [ɟ] than a fricative or affricate by the consultant whose pronunciation informs this description. Otherwise, pronunciations are similar to their IPA equivalents. In this paper, the following orthographic conventions are followed: *ñ* rather than [ɲ], *j* rather than [ʤ], and *y* rather than [j]. For the voiceless sonorants digraphs are used: hm [m̥], hn [n̥], hñ [ñ̥], hŋ [ŋ̊], and hl [l̥], and geminates are written as double letters. Regarding the geminates, the voiced stops all have a long counterpart, except for /ŋ/, for which no examples of a length contrast were found. This is likely a gap in the dataset and not an actual gap in the phonology since this would be an odd and unmotivated restriction, but /ŋŋ/ is listed in parentheses for now (see table 3).

3.1.1. Syllable shape and consonant clusters. Hliboi syllables allow complex onsets and codas, giving a maximum syllable of CCVCC in root words. With verbal prefixation more complex syllables are possible, including CCCVC and CCCVCC. These maximally complex syllables are restricted to monosyllabic words, and complex codas are restricted to word-final position. Complex codas are invariably of the shape CN, where C is a voiceless stop and N is a homorganic nasal (dubbed *preploded nasals* in many studies on languages of this area; see section 4.1.4 for more). Preploded word-final nasals are common in western Borneo where Hliboi is spoken, and in many languages they are predictable allophones of regular word-final nasals (final nasals are preploded only when preceded by a nonnasal consonant in the onset). Borrowing and sound change, however, have made word-final NC sequences unpredictable in Hliboi, for example, *bitotn* 'eye' versus *noton* 'to watch' (from Malay *nonton*, expected **nototn) and *kuatn* 'hornbill' versus *kawan* 'friend' (from Malay *kawan*, expected **kawatn). Still other examples of near-minimal pairs involve words with less obvious etymologies, for example, *hŋun* 'rattan' and *hŋotn* 'straight' (expected **hŋon). Table 4 contains examples of all possible syllable shapes. Note that all syllable shapes listed are found in monosyllabic words, with the exception of the minimally complex syllable V, which is only found in words of two or more syllables.

TABLE 3. HLIBOI CONSONANT PHONEMES.

	Labial	**Alveolar**	**Palatal**	**Velar**	**Glottal**
Voiceless plosive	p	t		k	ʔ
Voiced plosive	b/bb	d/dd	j/jj	g/gg	
Nasal	m/mm	n/nn	ñ/ññ	ŋ/(ŋŋ)	
Voiceless nasal	hm	hn	hñ	hŋ	
Voiceless fricative		s			h
Lateral			l		
Voiceless lateral			hl		
Glide	w		y		

TABLE 4. POSSIBLE SYLLABLE SHAPES IN HLIBOI.

Shape	Example words
V	*li.u* 'sky', *i.lay* 'road'
VC	*ud* 'upriver areas', *eh* 'that'
VCC	*akŋ* 'inside'
CVCC	*bikŋ* 'beetle', *supm* 'fast', *ditn* 'younger sibling'
CV	*ti* 'this'
CVC	*put* 'blowpipe', *nap* 'fish scale', *sud* 'kingfisher'
CCV	*bbi* 'ant', *gli* 'to lie down'
CCVC	*mput* 'to shoot a blowpipe', *klog* 'bone', *blid* 'mango fruit'
CCVCC	*ntitn* 'to remember', *ddakŋ* 'rice husk', *glupm* 'carry on the shoulder'
CCCVC	*mblip* 'to blink', *ŋglap* 'to overflow'
CCCVCC	*ŋglupm* 'set (of the sun)'

Word-initial two-consonant clusters in root words are either nasals (*m*, *n*, or *ŋ*) followed by a homorganic obstruent or *l* preceded by a heterorganic stop. Note that the glottal stop does not occur in clusters in any position. With morphology, initial clusters of three consonants are permissible where a homorganic nasal is prefixed before clusters involving a voiced stop and *l*, resulting in the following attested onsets: *m-bl-* and *ŋ-gl-*. In fact, most clusters that involve word-initial nasals are verbal, which suggests that they are morphologically complex homorganic nasal prefixes plus root words. Examples like *mbot* 'canine teeth' and *ŋkuʔ* 'mine', however, suggest that not all nasal-initial clusters involve verbal morphology. A list of all permissible onset clusters with examples is provided in table 5.

TABLE 5. POSSIBLE WORD-INITIAL CONSONANT CLUSTERS IN HLIBOI.

Category	Cluster shape	Example words
CL-	pl-	*pluʔ* 'multiple of ten', *plutn* 'to plant'
	kl-	*klit* 'skin', *klat* 'mushroom', *klog* 'bone'
	bl-	*bluʔ* 'bamboo', *blatn* 'moon', *blid* 'mango fruit'
	gl-	*gli* 'to lie down', *gluʔ* 'to sit', *glopm* 'carry on the shoulder
	ml-	*mliʔ* 'to split', *mlos* 'to wring', *mlin* 'to buy'
	ŋl-	*ŋluk* 'to pile up; bunch together'
NC-	mp-	*mpukŋ* 'to float', *mput* 'to shoot a blowpipe'
	mb-	*mbot* 'canine teeth'
	nt-	*ntitn* 'to remember', *ntaʔ* 'to vomit', *ntukŋ* 'to divide up'
	nd-	*ndus* 'to sweat', *ndik* 'to travel upriver'
	nj-	*njug* 'to stand', *njol* 'quiet', *njit* 'to pinch'
	ns-	*nsi* 'to paddle', *nsakŋ* 'to carry by a handle', *nsiʔ* 'to fill'
	ŋk-	*ŋkuʔ* 'mine', *ŋkit* 'to sting'
	ŋg-	*ŋgaʔ* 'to see'
N-CL-	m-bl-	*mblip* 'to blink'
	ŋ-gl-	*ŋglap* 'to overflow', *ŋglupm* 'to set (of the sun)

TABLE 6. EXAMPLES OF VOICELESS SONORANTS.

Voiceless sonorants	Example words
hl-	*hluʔ* 'firewood', *hluh* 'headhunting', *hlitn* 'to pour'
hm-	*hmuh* 'to sleepwalk', *hmit* 'sand; gums', *hmiʔ* 'food'
hn-	*hnuk* 'near', *hnukŋ* 'wall around a property', *hnuʔ* 'full'
hñ-	*hñi* 'a plate'
hŋ-	*hŋu* 'a dead tree', *hŋut* 'black', *hŋun* 'rattan'

3.1.2. Voiceless sonorants. All sonorants in Hliboi have a voiceless counterpart, *hl*, *hm*, *hn*, *hñ*, and *hŋ*. Although they are historically derived from clusters (see section 4.3.3 on the historical development of voiceless sonorants), their synchronic pronunciation is voiceless, and they are treated as single segments in this analysis. Examples of attested voiceless sonorants are organized below in table 6.

3.1.3. Geminate consonants. Hliboi is one of two languages in Borneo (the other being Sa'ban), with phonemic geminate consonants that are restricted to word-initial position. Geminates in Hliboi are always voiced and are restricted to the oral and nasal stops (see table 3). The attested geminates and examples are given in table 7. The restrictions on geminates, that they be both word-initial and voiced, run counter to general expectations of geminates which are expected to favor voiceless articulation (Jaeger 1978; Ohala 1983; Kirchner 1998; Hayes and Steriade 2004; Kawahara 2004) and are expected to favor medial position (Jaeger 1978; Taylor 1985; Muller 2001). Although these restrictions run counter to typological expectations, their presence in Hliboi can be straightforwardly explained.

The presence of word-initial geminates is not so surprising as multiple AN languages have geminates word-initially: Sa'ban (Blust 2001), Kiput (Blust 2003), Marshallese (Zewen 1977), Pattani Malay (Yupho 1989), and Trukese (Hart 1991), for example. Although there is disagreement about the underlying structure of such geminates, moraic onsets (Topintzi 2006, 2008, 2010) can straightforwardly explain the appearance of geminates in

TABLE 7. ATTESTED WORD-INITIAL GEMINATE CONSONANTS.

Geminate shape	Examples
bb-	*bbakŋ* 'hole', *bbi* 'ant', *bbit* 'short'
dd-	*ddaʔ* 'white', *dduk* 'sweet potato', *ddoh* 'sea turtle'
jj-	*jjakŋ* 'civet', *jji* 'slow loris', *jjuʔ* 'wet'
gg-	*ggug* 'rhinoceros', *ggay* 'stab', *ggitn* 'give'
mm-	*mmuk* 'soft; smooth', *mmut* 'moss'
nn-	*nnuk* 'banyan tree'
ññ-	*ññap* 'to count'

initial position in a synchronic grammar, by removing the stipulation that only coda consonants can bear weight. Although historically initial geminates arose through consonant coalescence across a syllable boundary after the deletion of penultimate vowels, they act as single segments synchronically and cannot be separated (by a schwa, for example). We may postulate that geminate consonants are moraic and that in Hliboi moraic consonants are restricted to onsets, although a more detailed investigation specifically regarding word-initial geminates is needed to fully understand their underlying structures.

Regarding the restriction against voiceless geminates, word-initial geminates confront a number of perceptual difficulties not present in word-medial position, which may explain Hliboi's preference for voiced over voiceless geminates. In any position, geminate stops present an articulatory difficulty which leads to avoidance of voicing, as it is difficult to maintain adequate airflow over the glottis as pressure builds in the oral cavity during articulation. Voiced geminates are, therefore, marked relative to their voiceless counterparts, and it is unexpected that a language might show a preference of voiced over voiceless geminates. Impressionistically, however, it is also expected that voiceless geminates will be more difficult to detect at word boundaries as there are fewer perceptual cues which may indicate the length of voiceless closure. Phonetic studies have shown this to be true. For example, Abramson (1999, 2004) shows that initial voiceless geminates in Pattani Malay rely more on fundamental frequency cues on the following vowel than do voiced initial geminates, indicating that voiceless geminates lack perceptual cues on their own and must rely on secondary cues. Furthermore, Ridouane and Hallé (2008) found that native speakers of Tashlhiyt Berber were only able to correctly identify voiceless word-initial geminates at a rate of 61%, compared to 96% for voiced geminates. These studies demonstrate that voiced geminates are more salient in word-initial position than voiceless geminates are, and from this one may predict that the implication for geminate voicing in initial position will be the opposite of that found in medial position. Hliboi's restriction on geminate voicing, which seems counterintuitive at first, may rather be the expected pattern for such a system, where geminates are found only in initial position. In such a system, the implication is that if there are voiceless word-initial geminates then there must also be voiced word-initial geminates, but not the reverse, and this implication is motivated by perceptual cues that constrain the shape of output geminates.

3.2. VOWELS. Hliboi has six vowels (*i*, *u*, *a*, *e*, *o*, and *ə*) as well as four phonemic diphthongs (*aw*, *ay*, *iw*, and *uy*) as indicated in table 8. The diphthongs appear in word-final position only. Five of the vowels *i*, *u*, *a*, *e*, and *o* may appear in any position, although native vocabulary reflects restrictions not found in borrowed vocabulary. In native vocabulary the penultimate syllable is highly restricted regarding allowable vowels. The vowel *i* is quite common in this position, whereas the other vowels only appear in a small handful of

TABLE 8. HLIBOI VOWELS AND DIPHTHONGS.

	Front	Central	Back
High	i		u
	iw		uy
Mid	e	ə	o
Low		a	
		ay, aw	

specifically conditioned environments in penultimate syllables. These same five vowels may appear in the final syllable, but only high vowels appear in open final syllables in native vocabulary. No such restrictions exist in borrowed vocabulary (mostly from Malay). Schwa only appears in borrowed vocabulary and is restricted to the penultimate position. The vowels are not monophthongal in word-final syllables and are instead realized as diphthongs.

With the exception of *e* and *ə*, all vowels are widely attested. Schwa was eliminated through historical change but appears to be an optional pronunciation of *a* in pre-penultimate position. A few examples, however, have schwa in penultimate position, where it forms meaningful contrasts with the other vowels, usually as a result of borrowing. Some examples of schwa in this position are *bəmakŋ* 'mantis', *bənay* 'large species of bamboo', and *gəlas* 'glass; cup'. Examples of *e* are also rare, but examples from native vocabulary include *bleh* 'red', *peʔet* 'bitter', *hnep* 'thin', and *ddeʔ* 'salty'. Regarding the diphthongs, *aw and *ay were eliminated through historical change but appear in a restricted set of exceptions in native vocabulary and have re-entered the language in abundance through borrowing. The diphthong *uy* is pronounced [oj], and *iw* is attested in a single word, *laŋiw* 'shrimp; prawn'.

3.2.1. Vowel breaking. Hliboi has an active system of vowel breaking and allophony which gives rise to complex surface forms of vowels in word-final syllables. There are two types of diphthongal vowel realizations in Hliboi: off-gliding of high vowels in closed final syllables (uə̯, iə̯, and oə̯), and nucleus lowering in open word-final syllables with peripheral off-glides (əu̯, əi̯, and əo̯). Note that although there is a distinct phoneme /e/, it is not subject to the same vowel-breaking processes as the other vowels. This may be due to a lack of robust attestation, as /e/ appears in relatively few words, and is only found word-finally in borrowed vocabulary.

Vowel breaking in closed word-final syllables has been recorded as a historical or synchronic process in a number of languages of Borneo. Example languages include Ngorek (Blust 1974), Mukah Melanau (Blust 1988), Uma Juman and Data Dian Kayan (Blust 1977; Smith 2017a), Kiput (Blust 2003), Merap (Smith 2017b), Kajang languages, and Punan Bah (Smith 2017a). The situation in Hliboi is different from these other examples, however, as most reported cases of final vowel breaking with a schwa-like off-glide are conditioned by the place of articulation of the following consonant. In Mukah Melanau, for example, /i/ is realized as [iə̯], /u/ as [uə̯], and /a/ as [eə̯]

before word-final velars *-k* and *-ŋ* (but not before *-g*) and also before word-final *-h* (from earlier *-R) but not before other word-final consonants. Minangkabau underwent a similar pattern of breaking, which is historically analyzable as being driven by final velar consonants, but not alveolars or labials (Adelaar 1992). In these and other reported cases of conditioned off-gliding, velar consonants act as the condition, but Hliboi has schwa off-glides before any word-final consonant, not just the velars, and a preference for this type of breaking before labial and alveolar codas. This implies that the condition for this type of vowel breaking in Hliboi is not the place of articulation of final consonants, but the presence of word-final consonants of any place of articulation.

Table 9 indicates the patterns of final-syllable high-vowel breaking in Hliboi. A plus (+) indicates that examples with the stated type of breaking were recorded in my field notes. A minus (−) indicates their absence. In open word-final syllables, vowel breaking always involves the lowering of the syllable nucleus. Thus, /u/ is realized as [ə̯u̯] and /o/ as [ə̯o̯], but interestingly, allophones of *i* are phonetically more complex. In several cases, the nucleus lowers without centralizing and may maintain a short high-front in-glide resulting in either the diphthong [ei̯] or the triphthong [i̯ei̯], both allophones of /i/. For brevity, however, əi̯ or əy is used for the various phonetic variations of /i/ in final position.

All vowels have schwa off-glides before labial and alveolar codas in closed word final syllables and lowered nuclei in word-final position. Table 9 shows a clear preference for schwa off-glides in closed word-final syllables, although there is variation with velar and glottal codas. /i/ has the cleanest distribution, with all lowered nuclei appearing in open syllables and schwa off-glides in closed syllables. *u* has significant overlap between both types of vowel breaking in syllables closed with glottal and velar consonants. *o* unexpectedly prefers lowered nuclei before velar and glottal codas, but there are at least three recorded tokens of [oə̯] before velars (*kibok* [ki̯boə̯k] ‘hat’, *alok* [aloə̯k] ‘a room’, and *kiokng* [kioə̯kŋ] ‘myna bird’). Note that *o* ultimately reflects *ə, and because it is a mid-vowel, may be subject to vowel breaking pressures which differ from *u* and *i*. PMP *ə was also banned from word-final position, which explains the arbitrary lack of *o* in word-final position.

Although the observations above tend to be inalterable properties of the word, there are a small number of examples of alternations where vowels with lowered-nuclei alternate with vowels with off-glides after suffixation with the

TABLE 9. VOWEL BREAKING PATTERNS OF /i/, /u/, AND /o/.

	/i/		/u/		/o/	
Condition	[iə̯]	[ə̯i̯]	[uə̯]	[ə̯u̯]	[oə̯]	[ə̯o̯]
Before final labial	+	–	+	–	+	–
Before final alveolar	+	–	+	–	+	–
Before final velar	+	–	+	+	(+)	+
Before final glottal	+	–	+	+	–	+
Word-finally	–	+	–	+	–	–

suffix *-n*. For example, there is an alternation between *nsiwoh* [nsiwəo̯h] 'to get married' and *siwotn* [siwo̯ətn] 'wife'.

3.2.2. The relationship between tense and lax vowels and breaking patterns. The development of schwa off-glides in closed syllables is linked to the phonetic laxing of high vowels in closed final syllables. In a process that may be reconstructable to PMP, but is nevertheless widespread in AN languages, high vowels are realized as lax allophones in closed word-final syllables. In Hliboi, vowels are lax in closed final syllables when pronounced carefully, so they are likely underlyingly lax in this position.

Long lax vowels are cross-linguistically prone to developing the type of vowel breaking described above, with schwa off-glides on lax vowels but not tense vowels, especially where lax vowels are long. In southern dialects of American English, for example, *hid* may be pronounced [hɪə̯d] or [hiə̯d] (with dissimilatory tensing), but *heed* is pronounced with a monophthong. Donegan (1978:121) has pointed out this tendency in the history of French, Spanish, and Faroese, and as a synchronic process in Malmo Swedish and Icelandic, in addition to southern American English.

From these observations, it is assumed that Hliboi inherited lax high vowels in closed final syllables from a proto-language and developed off-glides after stress-shift to the final syllable caused the vowels to lengthen. This surfaces in the synchronic phonology as distinct allophones: lowered nuclei (to schwa) with peripheral off-glides in open syllables, and a tendency for stable vowel nuclei and schwa off-glides in closed syllables.

3.3. REVIEW. To review, the synchronic phonology of Hliboi is of a type found in many other languages of Borneo; it has a relatively complex syllable structure, with an abundance of monosyllabic and sesquisyllabic words. Hliboi has a consonant inventory much like other languages of Borneo, but with additional contrasts between voiced and voiceless sonorants as well as a distinction between long and short voiced stops. Vowels are also much like other languages of Borneo but, as just discussed, undergo a system of conditioned vowel breaking in the final syllable that is linked to the laxing of otherwise tense vowels in closed final syllables. From here, the discussion turns to the historical phonology of Hliboi, which will shed light on the processes that led to some of the more interesting features of Hliboi phonology.

4. HLIBOI HISTORICAL PHONOLOGY. In this section, the historical phonology of Hliboi is discussed, with a special focus in later sections on the processes that gave rise to Hliboi's complex syllable shapes. Reconstructions are to PMP and are from Blust and Trussel (Ongoing) unless otherwise noted. PLD reconstructions are original but informed by data from Rensch et al. (2012) and Smith (2017a, 2019). Table 10 shows regular Hliboi reflexes of PMP phonemes. The Hliboi reflexes of PMP consonants are listed as they appear in all environments except at historically secondary consonant clusters, where

TABLE 10. HLIBOI REFLEXES OF PMP PHONEMES.

PMP	***p**	***t**	***c**	***k**	***q**	***b**	***d**	***j**	***z**	***g**	***m**	***n**	***ñ**	***ŋ**	***s**
Hliboi	p	t	s	k	ʔ	b	d/l/Ø	d	j	g	m/pm	n/tn	ñ	ŋ/kŋ	s
PMP	*h	*l	*R	*r	*w	*y	*a	*i	*u	*ə	*aw	*ay	*uy	*iw	
Hliboi	Ø	l/Ø	Ø/(y)	-	w	y	i/a	Ø/i	Ø/u	i/a/Ø	u	i	uy	-	

additional sound changes have had a significant impact. In some cases, sound correspondences cannot be stated due to a lack of data.

4.1. REFLEXES OF CONSONANTS EXCLUDING CONSONANTS AT WORD-INITIAL CLUSTERS. Hliboi's consonants are relatively stable outside of secondary consonant clusters that formed at word-initial position. Changes such as PMP *q > *ʔ*, *c > *s*, *j > *d*, *h > Ø, and *R > Ø are fairly common, especially in Borneo, and will not be discussed in detail. Neither will phonemes that did not change. The discussion will instead focus on reflexes of PMP *d, *l, and *R (which is important in relation to reflexes of *l), nasals in word-final position, and the vowels. PMP *r and *iw do not have reflexes and so cannot be discussed. Hliboi *ŋ-kuʔub* 'to lie prone' may ultimately reflect PMP *kurəb, providing a reflex of *r, but additional evidence is still needed to establish the regularity of this potential correspondence.

4.1.1. Reflexes of *d. PMP *d has numerous reflexes in initial position, with no apparent condition. It is deleted in: PMP *duha > *uoh* 'two', *daRaq > *iaʔ* 'blood', and *dəpah > *ipoh* 'a fathom'. In other cases, it is reflected with *l*, for example, *daqan > *laʔay* 'branch', *dahun > *liwoʔ* 'leaf', and PLD *dayuŋ > *layukŋ* 'woman'. Two PLD words that are reconstructed with *d are reflected unchanged, *daləd > *dilod* 'mountain' and *daʔaray > *dali* 'man'. The first change, *d- > Ø, is the only one with evidence that reflects PMP etyma with no irregularities. *laʔay* and *liwoʔ* both reflect irregularities in reflexes of *-n, and the words where *d remains unchanged cannot be reconstructed past PLD. It may therefore be best to describe *d as having been deleted in initial position, although with some words that appear to reflect the change *d > *l*. One may suggest that *laʔay* was borrowed from Iban after *d- had been deleted from initial position, since Iban languages often reflect final nasals as a diphthong (e.g., Iban *makay* from Proto-Malayic *makan 'to eat'), but this cannot be the case since no Ibanic languages reflect a diphthong in reflexes of *daqan. The word is instead reflected as Iban *dan.* Because the *d > *l* words lack an adequate explanation, they cannot yet be written off as a simple product of borrowing.

4.1.2. Reflexes of *l. One of the more widespread sound changes in Land Dayak is the shift of PMP *l to *r* in initial and medial position, often realized as a velar or uvular trill or fricative. The change is so widespread that PLD etyma are reconstructed with *r where PMP had *l (e.g., Rensch et al.

2012:141 reconstructs *kurit 'skin', where PMP had *kulit).[4] Hliboi reflects PMP *l with *l* in all cases, that is, the change *l > *r is not supported for PLD with Hliboi evidence, even though the evidence for PMP *l > PLD *r is otherwise overwhelming. Benyadu and Bekati' shifted *l to *r, as did nearly all Bidayuh languages and all of Southern LD. To compound the issue, changes of the liquid consonants in either direction (*l > *r* and *r > *l*) are equally plausible. That is, *l > *r* is not a unidirectional sound change like *s > *h*. Polynesian languages contain additional examples of the bidirectionality of this change. Proto-Polynesian *l and *r merged in Proto-Nuclear-Polynesian, only to shift again from Proto-Nuclear-Polynesian in numerous daughter languages (e.g., Hawaiian reflects this merger with *l*, whereas Maori or Tikopian reflects the merger with *r*). Because the change *l > *r* is otherwise fully represented across primary divisions in LD, the possibility that the earlier shift of PMP *l > PLD *r was "undone" in Hliboi cannot be discounted.

Several reflexes of PMP *l are given below in initial, medial, and final positions in (1). In word-final position it appears that *-l was deleted, but there are few apparent reflexes. In the examples listed below, PLD appears to have irregularly changed *k to *t from PMP *kazəl to PLD *tajə, but there are no other clear-cut reflexes of *-l in Hliboi. A possible second reflex is Hliboi *hŋu* 'a dead tree' from *tuŋgul, but the reconstruction is not listed on the ACD.[5] Evidence from other LD languages, however, supports a change of PMP *-l > PLD Ø. For example, PMP *kapal 'thick' is reconstructed as *kapa with examples from Benyadu *kapa*, Bukar *kəpa*, and Kembayan *kopa*.

(1) *labuq > *libuʔ* 'to fall; drop', *laqia > *liʔi* 'ginger', *kulit > *klit* 'skin', *puluq > *pluʔ* 'multiple of ten', *salaR > *silitn* 'animal nest; haunt', *kazəl > *tajo* 'dull; bunt' (initial *t-* irregular), *tuŋgul > *hŋu* 'dead tree' (original reconstruction)

4.1.3. Reflexes of *R. The shift of *l to *r* did not result in a merger of *l and *R, although it may appear so in some Malay borrowings (e.g., Hliboi *hlatus* 'one hundred' from Malay *seratus*, itself from *sa-Ratus). In Hliboi, PMP *R was deleted in all environments. In word-final position, where *R appears to be reflected by *h*, it is assumed that *R became zero, then the final syllable was closed when all open final syllables were closed with *h* in Proto-Bidayuh-Southern LD (PB-SLD) (Smith 2019). Several examples are listed in (2).

(2) *Raya > *iuh* 'big; large', *daRaq > *iaʔ* 'blood', *uRat > *aat* 'vein', *qaRəm > *uopm* 'scaly ant eater', *ikuR > *kutn* 'tail', *bəsuR > *jjuh* 'full; satiated', *təluR > *kluh* 'egg'

In word-final position, there is one case where *R is unexpectedly reflected with *i* (where it is assumed to have first become *y and later *i* through merger

4. Note that Rensch et al. (2012) reconstruct both PLD *r and *l. However, as pointed out in Smith (2019), their PLD *l is almost composed entirely of borrowings from a Malayic source.
5. Evidence for this reconstruction comes from various sources, including Malay *tuŋgul* 'tree stump', Iban *tuŋgul*, Benyadu *toŋu*, Tunjung *tuŋur*, Punan Tubu *tuŋun*, and Kenyah (highland) *tuŋun*.

with a proceeding vowel): PMP *salaR > *silitn* 'animal nest; haunt'. Irregular cases of the change PMP *R > *y* in languages, where *R did not regularly become *y*, are not unheard of in AN languages. Even in other LD languages, there are cases, where *-R became *y*, that do not appear related to the Hliboi case. For example, Sungkung *kuy* 'tail' reflects PMP *ikuR, but Hliboi has a regular reflex in *kutn* (with a possessive suffix, but no *y*).

4.1.4. Reflexes of nasals in word-final position. In a widespread phenomenon concentrated in AN and Aslian (Mon-Khmer) languages of mainland and western island Southeast Asia, word-final nasal consonants developed a short, homorganic oral stop immediately before the nasal (Adelaar 1995; Blust 1997; Phillips 2005). Preplosion occurs in Southeast Asia only in nasal consonants in historically word-final position, and only when preceded by a phonetically oral (nonnasal) vowel.[6] The oral component of preploded nasals can be voiced or voiceless, and in some cases the oral component has come to completely replace the original nasal. Examples of preploded nasal phenomena in Borneo include Bekati' *bulat*, Hliboi *blatn*, and Bonggi (North Borneo) *bulaidn*, which all reflect PMP *bulan 'moon' with different realizations of the same word-final nasal preplosion phenomenon.

Blust (1997) points out that the languages where nasal preplosion occurs have rightward (onset-driven) nasal spreading, so that the vowels following nasal consonants are nasalized (a syllable *na* will have a nasal vowel [nã] whereas a syllable *an* will not, [an]). Since preploded nasals occur after oral but not nasal vowels, it follows that word-final nasals that appear after nasal onsets will not have prepolosion. Hliboi follows this pattern and reflects word-final nasals with a voiceless prenasal plosive, as in *qaRəm > *uopm* 'scaly anteater' and *lubaŋ > *bbakŋ* 'hole', but as single nasals where the onset of the final syllable was also a nasal as in *ənəm > *nom* 'six' and *banah-n > *binon* 'husband'.

In Hliboi, sound change and borrowing have covered up the environment, where preplosion is predicted, resulting in phonemic contrasts in the modern language between simple codas *m*, *n*, and *ŋ* and complex codas *pm*, *tn*, and *kŋ* (a similar phonemicization of preploded nasals in Benyadu is described in Jardine et al. 2015). In native vocabulary, PLD nasal-obstruent clusters in medial position *mb, *nd, and *ŋg did not nasalize the following vowel which resulted in preplosion where the coda was a nasal. These medial clusters were later simplified by deleting the oral consonant, resulting in *m*, *n*, and *ŋ*, but preplosion remained on the final nasal resulting in preploded nasals in unexpected nasal environments. Examples include PLD *mandam > *mandapm > Hliboi *minapm* 'sick' and *kambiŋ > *kambikŋ > Hliboi *kimikŋ* 'goat'. In borrowed vocabulary, preploded nasals are not found in oral environments where they are

6. An anonymous reviewer points out that with suffixation word-final preploded consonants may appear in word-medial position. Some provided examples from Salako include *ng-inyàpm* 'to borrow' > *ng-inyapm-i* 'to lend' and *ng-inyapm-i-à* 'in order to lend'.

expected, for example, Hliboi *noton* 'to watch' from Malay *menonton* and Hliboi *goleŋ* 'to fry' from Malay *goreng*.

4.2. VOWELS. This section discusses the historical phonology of Hliboi vowels. Because different environments condition sound change to such a degree, the section is organized into vowels in closed final syllables, open final syllables, and finally in penultimate syllables. The unique phonology of borrowed vocabulary is also discussed.

4.2.1. Vowel change in closed final syllables. In closed final syllables, PMP vowels are phonemically stable, although there are some irregularities and conditioned exceptions. Typically, PMP *i, *a, and *u did not change and *ə became Hliboi *o*.

(3) Reflexes of *a in final syllables:
*lubaŋ > *bbakŋ*, *nanaq 'pus' > *ninaʔ*, *əpat > *pat*, *utaq 'vomit' > *taʔ*

(4) Reflexes of *i in final syllables:
*kulit 'skin' > *klit*, *qudip 'life; alive' > *dip*, *bətis 'calf of the leg' > *ddis*, *huaji 'younger sibling of the same sex' > *ditn* 'younger sibling'

(5) Reflexes of *u in final syllables:
*manuk 'chicken' > *manuk* 'bird', *buluq 'bamboo' > *bluʔ*, *tutuŋ 'aflame' > *tukŋ*, *ləsuŋ 'rice mortar' > sukŋ

(6) Reflexes of *ə in final syllables:
*ənəm 'six' > *nom*, *təbəŋ 'to fell trees' > *tibokŋ*, *jipən 'tooth' > *bbotn*, *bisəq 'wet' > *jjoʔ*, Proto-Western Indonesia *ukəd > *kod* 'western tarsier'

4.2.2. Irregular reflexes of *a in closed final syllables. Although *a typically did not change in closed final syllables, there are numerous exceptions where *a fronted and raised either to /e/ or /i/ in closed syllables. Borrowing is not an adequate explanation for the patterns observed below, nor is low-vowel-raising, a phenomena that Blust (2000) describes as only affecting low vowels after voiced consonants (either immediately after voiced consonants or at a distance). The reflex of *kaka 'elder sibling' as *kiʔ* demonstrates that the irregularities observed in Hliboi are of a different nature. A full list of unexpected fronting and raising of PMP *a is given in table 11.

Raising of *a in *kitn* 'fish' is a change Hliboi shares with other Bau-Jagoi-Biatah languages, so it is likely an inheritance and not a Hliboi-specific change. The other examples, however, are not corroborated with examples from other languages, and no condition has been identified that may explain these examples.

4.2.3. Vowels in open word-final syllables. In native vocabulary open final syllables were closed with *h*. In the vowels, *a shifted to *o* (and merged with *ə), but *i and *u did not change, although they are synchronically realized as diphthongs. The addition of *h* after open final syllable is reconstructable to PB-SLD, a large subgroup within LD which includes Hliboi (Smith 2017a).

TABLE 11. IRREGULAR FRONTING AND RAISING OF *a IN CLOSED FINAL SYLLABLES.

	PMP	Hliboi	Gloss
	*buntan	ddetn	'coconut'
	*qəlad	lid	'wing'
	*hikan	kitn	'fish'
	*kaka	kiʔ	'elder sibling'
	*dəŋan	ŋin	'with'
PLD	*baram	alepm	'rice wine'

Note that cases of phonemic *u* and *i* in final position in Hliboi are either monophthongized reflexes of *-aw and *ay (where etymologies are available) or borrowings. In the examples below, PB-SLD *-h is retained after *a and *u. After word-final *i, however, we find multiple instances of an unexplained word-final *n*. It is not clear where this consonant came from, for example, if it is morphological. Not every example of *i* in word-final position has this unexplained final nasal, and one example, *miih* from PLD *mahi 'eight' has been included.

(7) Reflexes of *a in word-final position:
*lima 'five' > *moh*, *tawa 'laugh' > *tiwoh*, *duha 'two' > *dua > *uoh*, *qasawa 'spouse' > *nsisoh* 'to marry', *dəpa 'length of outstretched arms' > *kipoh* (*ka-* 'one' *ipoh* 'length of outstretched arms')

(8) Reflexes of *u in word-final position:
*batu 'stone' > *batuh*, *kahiw 'wood; tree' > *kayu > *kiuh*, *təbuh 'sugar cane' > *tibuh*, *qahəlu 'large pestle for rice' > *aluh*

(9) Reflexes of *i in word-final position, with unexplained word-final *n* in many examples:
*bəli 'to buy' > *mlitn*, PLD *asi 'who' > *isitn*, *kalih 'to dig' > *kali > *kalitn*, PLD *mahi 'eight' > *miih*

4.2.4. Word-final vowels and borrowed vocabulary. Hliboi appears to have fronted and raised word-final *a* to *-e* only in Malay loans (table 12). However, it was pointed out that the pattern of final vowel fronting in Malay loans in Hliboi follows from regular reflexes of word-final *-a* in the Sambas dialect of Malay, which is spoken in Sambas regency which neighbors Bengkayang Regency. These examples demonstrate that the source of Malay vocabulary in Hliboi is from the local Sambas dialect rather than from standard dialects.

4.2.5. Penultimate vowels. As a general rule, nonlow penultimate vowels deleted, creating a plethora of monosyllabic content words in native vocabulary. PMP *a is the only vowel that is regularly retained (where it shifted to *i*), while *ə is retained where it merged with *a (and both later shifted to *i*) but deleted elsewhere.

(10) Reflexes of *a in penultimate position:
*aku 'I, me' > *ikuʔ*, *pajay 'padi rice' > *pidi*, *apuy 'fire' > *ipuy*, *anak 'child' > *inak*, *qatay 'liver' > *ititn*

TABLE 12. FRONTING /a/ IN SAMBAS MALAY LOAN WORDS.

Malay	Hliboi	Gloss
buŋa	buŋe	‘flower’
cerita	lete	‘story’
meja	meje	‘table’
biasa	base	‘common; normal’

(11) Reflexes of *i in penultimate position:
*silu ‘finger nail; claw’ > *hlutn*, *ikuR ‘tail’ > *kutn*, *bibiR ‘lips’ > *bbitn*, *jipən ‘tooth’ > *bbotn*

(12) Reflexes of *u in penultimate position:
*bulu ‘body hair’ > *blutn*, *buntan ‘ripe coconut’ > *ddetn* ‘coconut’, *qudip ‘life; alive’ > *dip*, *lubaŋ > *bbakŋ*

(13) Reflexes of *ə in penultimate position:
a. Deletion:
*bəsuR ‘full; satiated’ > *jjuh*, *pənuq ‘full’ > *hnuʔ*, *bətis ‘calf of the leg’ > *ddis*
b. Merger with *a followed by raising to *i*:
*təbuh ‘sugarcane’ > *tibuh*, *təbəŋ ‘to fell trees’ > *tibokŋ*, PLD *kəbəs ‘to die’ > *kibos*

The wholesale deletion of nonlow penultimate vowels is unique to Hliboi amongst LD languages. Other LD languages either retain all penultimate vowels or reflect an intermediate stage where penultimate vowels merged as *ə*. Still other languages show irregular deletion of nonlow vowels, suggesting that the change is spreading through a complex network of sound change, similar to the wave model of linguistic change. In table 13, reflexes of words with nonlow penultimate vowels are shown in six Bau-Jagoi-Biatah languages, including Hliboi. Hliboi deletes all nonlow penultimate vowels regularly, whereas the other languages have an unstructured mixture of retention, reduction (to *a*), and deletion. Note that in this table both Hliboi and T. Bireng reflexes of

TABLE 13. DELETION, REDUCTION, AND RETENTION OF PMP *i, *u, AND *ə.

PMP	Hliboi	Bistaang	Benuk	Sembaan	T. Raya	T. Bireng	Gloss
*zipən	bbotn	japəh	jpəh	pəh	jipəh	jipən	‘tooth’
*kulit	klɪt	krit	kurit	hrit	krit	kurit	‘skin’
*bulu	bləu̯tn	bruh	bruh	bruh	bruh	bruʔ	‘body hair’
*tuqelaŋ (>*tulaŋ)	kləu̯g	traŋ	traŋ	hraŋ	traŋ	trəg	‘bone’
*kutu	ddutn	gatis	gatis	gutih	gutih	gutih	‘louse’
*buntan	ddetn	batan	b(a)tan	tan	butan	batan	‘coconut’
*bulan	blátn	bran	bran	bran	bran	bran	‘moon’
*təluR (> *turəh)	kluə̯h	turoh	turoh	turoh	turoh	troh	‘egg’
*zəlaq (> *jiraʔ)	glaʔ	jaraʔ	jiraʔ	graʔ	juraʔ	juraʔ	‘tongue’

TABLE 14. REDUCTION OF *a IN BAU-JAGOI.

PMP	Hliboi	Singai	Serambu	Bratak	Grogo	Stass	Bengoh	Gloss
*taki	tikiʔ	təkiʔ	təkiʔ	təkiʔ	təkiʔ	təkiʔ	təkiʔ	'excrement'
*kayu	kiuh	kəyuh	kəyuh	kəyuh	kəyuh	kəyuh	kəyuh	'tree'
*dahun	liwoʔ	dəwən	dəwən	dəwən	dəwən	dəwən	dəwən	'leaf'
*laŋit	liụ	rəŋit	rəŋit	rəŋit	rəŋit	raŋit	raŋit	'sky'
*panaw	pinoy	pənu	pənu	pənu	pənu	pənu	pənu	'walk'
*zalan	ilay	əran	əran	əran	əran	əran	əran	'road'

*tuqəlaŋ show an unexpected *-ŋ > *-g* sound change which is, for now, unexplained.

The shift of *a to *i* in Hliboi penultimate syllables likely went through an intermediate stage where *a first became *ə (Smith 2019 reconstructs a phonetic pronunciation of [ə] for /a/ in penultimate syllables all the way to PLD). All other Bau-Jagoi languages reflect *a with *ə* in this position, as shown in table 14.

4.2.6. More on the merger of *a and *ə. Smith (2017a) first pointed out an apparent split in reflexes of *ə, where *ə merged with *a in the penultimate syllable, typically as Hliboi /i/. Merger did not occur, however, where the onset of the penultimate syllable was a labial. In this environment, *ə was deleted. This pattern is regular, although there are two apparent exceptions where *ə appears to have deleted in an environment where it was expected to merge with *a. First, Hliboi reflects PMP *təluR 'egg' with *kluh*, where **tiluh is expected. However, in this word PMP *ə and *a underwent metathesis, producing PLD *tura, and was further altered to *turu in several languages: Sungkung *tulah*, Bekati *turaʔ*, Jangkang *turo*, and Ribun *tuhu*. Hliboi *kluh*, therefore, is not an exception. Second, PMP *zəlaq 'tongue' became Hliboi *glaʔ*, not expected **jilaʔ, but again, the comparative data support an irregular reflex of *a in PLD *jilaʔ: Sungkung *jila*, Jangkang *jira*, and Ribun *jiho*. Like *kluh*, these two words are therefore not actual exceptions to the merger rule. A list of words showing this merger are organized in table 15.

The question that remains is why merger occurred after all consonants except labials. AN languages are known for labial-onset specific phonotactic and morpho-pohonological alternations, where labial consonants appear in successive onsets (see Blust 2004 for a wider survey or Blust and Nielsen 2016). In these cases, dissimilar labials pVb-, pVm-, bVp-, and so forth were nearly absent from the phonology of Proto-Austronesian (PAN) and actively avoided in the phonology of daughter languages (Zuraw and Lu 2009). In those cases, however, it is the *labial . . . labial* sequence that is penalized but only where the labials are not identical. In Hliboi, the unexpected split in reflexes of schwa is motivated by the simple presence or absence of a labial in word initial position. The phenomena are thus unrelated. Phonologically, it provides an interesting puzzle, but one whose underlying motivation remains unclear.

TABLE 15. THE EFFECT OF LABIAL ONSETS ON THE MERGER OF *ə AND *a.

	PMP	Hliboi	Gloss
	*bəsuR	jjuh	'full; satiated'
	*pənuq	hnuʔ	'full'
	*bətis	ddis	'calf of the leg'
	*bəli	mlitn	'to buy'
PLD	*pədeʔ	ddeʔ	'salty'
	*təbu	tibuh	'sugarcane'
	*təbəŋ	tibokŋ	'to fell trees'
	*dəpa	ipoh	'fathom'
	*təlu	taluh	'three'
PLD	*kəbəs	kibos	'to die'

4.2.7. Penultimate vowels before glottal stop. Where PMP etyma are available, vowels in penultimate position before word-medial glottal stop have historically resisted weakening, as shown in table 16. The first three examples show *a reflected with *i* in penultimate position before a glottal stop, which is expected, but these are followed by four cases where the penultimate vowel is unexpectedly unchanged. One of these cases, PMP *buqaya > Hliboi *baʔay* does not delete the high vowel, but rather irregularly shifts the vowel to *a* (note that all other LD languages reflect PLD *buʔay). Reflexes of PMP *tuqəd and *paqit have mid-vowels in the penultimate position. Finally, PLD *bəʔəs and *piʔi both have high vowels unexpectedly in the penultimate syllable.

The data show an avoidance of vowel deletion in environments, where penultimate vowels would otherwise delete before a glottal stop. This, in turn, suggests that vowel deletion was avoided as an active process of avoiding consonant clusters with a glottal stop. Hliboi phonotactics, as stated earlier, bans clusters involving glottal stop, so this is a structurally motivated avoidance technique.

TABLE 16. VOWEL RETENTION BEFORE GLOTTAL STOP.

	PMP	Hliboi	Gloss
	*laqia	liʔi	'ginger'
	*zaqit	niʔit	'to sew'
	*taqu	tiʔuh	'right side'
	*zaqat	jaʔat	'bad'
	*daqan	laʔay	'branch'
	*buqaya	baʔay	'crocodile'
	*baqəRu	baʔuh	'new'
	*tuqəd	toʔod	'stump'
	*paqit	peʔet	'bitter'
PLD	*bəʔəs	buʔus	'sleep'
PLD	*piʔi	piʔi	'nine'

There also appears to be harmony pressures acting on vowels before glottal stops. In the three examples, where *a became *i*, the expected reflex, there are high vowels in the final syllable, and in most of the cases where *a did not raise the final syllable vowel is *a*. This explanation does not work for all cases, however, since the penultimate vowel in *baʔuh* 'new' failed to harmonize even though it is followed by a high vowel. Other than this single exception, all other cases of medial glottal stop show height harmony between the penultimate and final vowel in words with established etymologies.[7]

4.3. SOUND CHANGE IN WORD-INITIAL CONSONANT CLUSTERS. Hliboi's historical phonology has increased syllable complexity as the result of penultimate vowel deletion described in section 4.2.7. The resulting consonant clusters have undergone a number of changes, of which voicing and place of articulation assimilations have played the largest role in the development of Hliboi's phonology. Total assimilation of consonants is widespread, which gave rise to the word-initial geminates. The historical developments of complex onsets are described in the following sections.

4.3.1. The emergence of word-initial geminates and voicing. With nonsonorant consonants, if there was a voiced segment in any position, all onset consonants become voiced after the penultimate vowel was deleted and the consonants later fully assimilated for place, resulting in geminate consonants. If, for example, D is any voiced nonsonorant and T any voiceless nonsonorant, *DT- and *TD- both became DD in Hliboi, as indicated in tables 17 and 18, respectively. Where nasals appear as the initial segment of a consonant cluster, they pattern with nonsonorants (they assimilate to the place and manner of articulation of the following consonant and trigger voicing assimilation; see the development of *musaŋ in table 17) but where they appear as the second segment, they lose voicing after voiceless plosives and after voiced segments, and they trigger place and manner assimilation, creating nasal geminates (e.g., *pənuq > *hnuʔ* 'full' and *lumut > *mmut* 'moss').

The question remains as to why a voiced segment in *any* position within the onset cluster results in voicing, rather than, for example, the first segment assimilating to the voice of the second segment, or vice versa. As noted earlier, the preference for voiced rather than voiceless geminates in Hliboi is a result of the greater perceptibility of length in voiced consonants in initial position. The voiced output of onset assimilation may therefore be explained as a product of perceptual forces. In formal terms, a perceptually motivated constraint against voicelessness in word-initial geminates being sufficiently highly ranked can force assimilation to voiced wherever gemination occurs. This may also explain the lack of voice assimilation in cases where geminates are not formed (clusters with *l* as the second element, for example).

7. *naʔuy* 'splash', *saʔoh* 'punting pole', and *kaʔut* 'to bite' show that harmony is not strictly required in the synchronic phonology, but these words do not have etymologies that allow for a historical analysis.

TABLE 17. *DT > DD VOICING IN WORD-INITIAL CONSONANT CLUSTERS.

PMP	Hliboi	Gloss
*bətis	ddis	'calf of the leg'
*gutu	ddutn	'head louse'
*bəsuR	jjuh	'full; satiated'
*musaŋ	jjakŋ	'civet'

TABLE 18. *TD > DD VOICING IN WORD-INITIAL CONSONANT CLUSTERS.

	PMP	Hliboi	Gloss
	*tuba	bboh	'derris root'
PLD	*subi	bbi	'ant'
PLD	*kuduk	dduk	'taro'

TABLE 19. EXAMPLES OF *C_1 (PLACE) > C_2 (PLACE).

	PMP	Intermediate stage	Hliboi	Gloss
	*bətis	**btis	ddis	'calf of the leg'
	*bəsuR	**bsuh	jjuh	'satiated; full'
PLD	*bujaŋ	**bjaŋ	jjakŋ	'adult'
	*tuba	**tbəh	bboh	'derris root'
	*lubaŋ	**lbaŋ	bbakŋ	'hole'
	*gutu	**gtuh	dduh	'louse'

The other assimilation that took place in initial clusters, place assimilation, operated unidirectionally: The first segment always assimilated to the place of the second segment, *C_1 (PLACE) > C_2 (PLACE). Geminates that formed from words with *s as the second segment further shifted to *j*, apparently due to a ban on geminate continuants. Examples demonstrating place assimilation are organized in table 19.

4.3.2. Dissimilation, voicing, and *l. PMP *l had a unique impact on consonant clusters in Hliboi, where it appears as the second segment. Where C_2 was *l, plosive stops did not trigger any voice assimilation, but where *s appeared before *l in a consonant cluster devoicing was triggered (producing [l̥]). Table 20 gives several examples.

TABLE 20. NO VOICE ASSIMILATION BEFORE l IN CONSONANT CLUSTERS.

PMP	Hliboi	Gloss
*puluq	pluʔ	'multiple of ten'
*kulat	klat	'mushroom'
*kulit	klit	'skin'

TABLE 21. EXAMPLES OF PLACE-DISSIMILATION BEFORE l.

PMP	Hliboi	Gloss
*təluR	kluh	'tail'
*tələn	klotn	'to swallow'
*zəlaq	glaʔ	'tongue'

PMP *l is also the only consonant that triggered place dissimilation in C_2 position. In such cases, *t became *k*, and *z (*[ʤ]) became *g* before *l in a consonant cluster. Table 21 gives several examples. Dissimilation before *l* is not surprising, since this change is motivated by a cross-linguistic dispreference for alveolar/dental-lateral clusters.

One may postulate that the shift affected all coronals, including *d, but no l-clusters involving *d are attested in the dataset, so it is not yet known if a cluster of the intermediate shape *dl- would have dissimilated to *gl-*. Velar and labial consonants did not change before *l.

4.3.3. Sonorant devoicing. Voiceless sonorants emerged in Hliboi through two paths: first, the devoicing of *l* when it was the second member of a cluster involving *s and, second, the devoicing of nasals which were preceded by any voiceless consonant in consonant clusters. In table 22, etymologies are shown for the voiceless sonorants *hl*, *hm*, *hn*, and *hŋ*. Although *hñ* is attested in the dataset (*hñi* 'plate'), it is not known in any words with established etymologies. The deletion of *l in word-final position, shown in reflexes of *tuŋgul, was discussed in section 4.1.2.

4.3.4. Clusters without voiced segments. The historical phonology of derived consonant clusters where at least one of the segments was voiced is well understood; derived clusters evolved into geminate consonants, voiceless sonorants, or clusters with *l* as the second element. The historical phonology of derived clusters where both consonants are voiceless obstruents is less well understood. This is most likely due to fewer examples of C[-VOICE]VC

TABLE 22. NASAL DEVOICING IN CONSONANT CLUSTERS.

	PMP	Hliboi	Gloss
	*silu	hlutn	'finger nail; claw'
	*pənuq	hnuʔ	'full'
	*tuŋgul	hŋu	'dead tree'
PLD	*sumat	hmit	'sand'
PLD	*pumən/pimən	hmon	'to dream'

[-VOICE] words in the reconstructed PMP lexicon compared to words where either of the segments is voiced. Four examples support the hypothesis that such clusters reduced to singleton stops, and two of these suggest that reduction to singleton stops occurred after the deletion of the initial segment. Two words which clearly reflect PMP etyma are *tukŋ* 'burn' and *suh* 'breast', from *tutuŋ and *susu, respectively. These two words cannot tell us if the first or second segment deleted, because both segments (the onset of the penult and the onset of the ultima) are identical. There are two additional examples of words which reflect nonidentical voiceless segments, but these words are not reconstructable to PMP. These words are *put* 'blowpipe' from PB-SLD *simput and *pak* 'to peel skin of fruit or animal' from PLD *kupak. Although these words do not follow from established PMP reconstructions, they are nevertheless supported by evidence from other LD languages as legitimate PLD and PB-SLD reconstructions. Examples include Singai *sipot*, Biatah *sipot*, and Bukar *simpot* 'blowpipe', as well as Benyadu *ŋopak*, Sungkung *kupak*, and Golik *ŋukap* 'to peel skin of fruit or animal'.

5. RELATIVE CHRONOLOGY. The relative chronology of historical sound change in Hliboi demonstrates the snowball effect of stress realignment followed by the reduction of formerly stressed penultimate syllables. Although not all LD languages were affected by stress shift in this way, Hliboi demonstrates the potential for typologically uncommon change to arise from this type of stress realignment.

The relative chronology in table 23 begins with PLD, where important changes such as the realignment of stress to the final syllable, the shift of *l

TABLE 23. HLIBOI SOUND CHANGE RELATIVE CHRONOLOGY.

Stage 1 PLD	Stress realignment
	*l > r
	*-a > *-ə
	penultimate *a pronounced as [ə]
	penultimate *ə pronounced as [ɨ]
Stage 2 PB-SLD	*-V > *Vh
	*aw, *ay > *u, *i
	merge *ə and *a as *a in penultimate position after nonlabial onsets
Stage 3 PB-J-B	delete the nasal in *NT clusters
Stage 4 Hliboi	shift PLD *r to l
	delete nonlow penultimate vowels
	shift penultimate *a [ə] to i
	shift final-syllable *ə to o
	assimilate word-initial cluster voicing
	assimilate word-initial place of articulation
	dissimilate word-initial clusters with l
	devoice nasals after voiceless stops in clusters
	devoice l after s in clusters

to PLD *r, and changes to vowel realization are reconstructed (Smith 2019). Next are changes that are reconstructed to PB-SLD, including monophthongization of *aw to *u and *ay to *i, as well as the closure of word-final vowels with *h and the merger of *ə and *a after nonlabial onsets in penultimate position. In the table, word-final vowel closure is listed first, because it must have occurred before diphthong monophthongization, otherwise monophthongization would have fed open-syllable closure. The singular piece of regular sound change defining the Bau-Jagoi-Biatah subgroup is presented next: the deletion of the nasal component of inherited NT clusters. Finally, sound changes that are specific to Hliboi are listed. Important ordering relationships are that the deletion of nonlow penultimate vowels must have occurred before *a shifted to *i* in the penult, and, of course, vowel deletion must have occurred before any of the resulting sound changes that arose from cluster assimilation.

6. CONCLUSION. The history of sound change in Hliboi Bidayuh is characterized by phonetically driven change which, through time, generated increased markedness in syllable shape. From this an obvious question emerges: Why did many AN languages maintain the PAN preference for a disyllabic word canon, a maximally complex CVC syllable, and a ban on complex onsets and codas, where a small number of languages, mostly in the western half of the AN speaking world, depart from the inherited word and syllable structure and move instead toward sesquisyllablic and monosyllbic word canons, increased syllable complexity, and word-edge consonant cluster innovation? In Hliboi, like many other languages in Borneo, these changes occurred after stress realignment from trochaic and penultimate to iambic and word-final.

Unstressed penultimate syllable deletion fed other phonological changes, in addition to syllable complexification. The innovation of word-initial geminates, onset clusters, and voiceless sonorants are all direct results of unstressed syllable deletion. The vowel breaking patterns that were observed in word-final syllables are also the result of the stressing and lengthening of historically unstressed word-final syllables. Hliboi and many other languages in Borneo are thus converging on a Mainland Southeast Asian typology of the type found in Kra-Dai and Mon-Khmer (Shorto et al. 2006; Pittayaporn 2009). This convergence occurs in what Smith (2017b) called the Central Bornean Linguistic Area, of which Hliboi is a clear member. However, this convergence is not occurring in a manner that can easily be explained as a consequence of diffusion, contact, substrata, or areal influence. Rather, the Central Bornean Linguistic Area consists of a small number of languages found here and there, often isolated from one another by hundreds of miles of mountainous terrain. Sa'ban, which is spoken some 400 miles away from Hliboi, shows strikingly parallel changes already discussed in this paper. Even greater distance is found between Hliboi and Merap, yet another isolated language on Borneo with many parallel sound changes. The problem of

identifying a satisfactory explanation for the emergence of the Central Bornean Linguistic Area, as well as the relative isolation of member languages, will likely persist for some time.

APPENDIX I

EVIDENCE FOR BAU-JAGOI-BIATAH

Deletion of the nasal in NT clusters

(14) PMP *buntan 'coconut'
a. Singai *butan*, Grogo *butan*, Hliboi *ddetn*, Biatah *butan*, Tringgus Raya *butan*
b. Bukar *buntan*, Sadong *buntan*

(15) PLD *ŋəmpa 'pound rice with a mortar and pestle'
a. Singai *pəh*, Grogo *pəh*, Hliboi *potn*, Biatah *pəh*, Tringgus Raya *pən*
b. Bukar *ŋumpəh*, Sadong *ŋumpəh*
c. Golik *ŋəmpəh*, Ribun *ŋimpuh*
d. Benyadu *ŋampa*

(16) PLD *naŋkaw 'to steal' (PMP *takaw/*nakaw, but evidence from across primary branches supports the reconstruction of -ŋk- to PLD)
a. Singai *nəku*, Grogo *nəku*, Hliboi *niku*, Biatah *nəku*, Tringgus Raya *nəku*
b. Bukar *nəŋku*, Sadong *nəŋku*
c. Golik *noŋku*, Jangkang *noŋku*, Ribun *noŋku*
d. Benyadu *naŋko*

(17) PLD *untək 'brain' (PMP *utək, but evidence from across primary branches supports the reconstruction of -nt- to PLD)
a. Singai *ətək*, Grogo *ətək*, Hliboi *itok*, Biatah *ətak*, Tringgus Raya *ətək*
b. Bukar *əntək*, Sadong *əntək*
c. Jangkang *ntoʔ*, Ribun *ntoʔ*
d. Bekati' *untuʔ*

Deletion of *j- from PLD *jalan 'road'

(18) Singai *əran*, Grogo *əran*, Hliboi *ilay*, Biatah *aran*, Tringgus Raya *əran*
Bukar *jəran*, Sadong *jəran*

Fronting of *a in reflexes of *ikan 'fish'

(19) Singai *ken*, Grogo *iken*, Hliboi *kitn*, Biatah *iken*, Tringgus Raya *ken*
Bukar *ikan*, Sadong *ikan*

Exclusively shared lexical replacement innovations:

(20) Bau-Jagoi-Biatah *arəʔ 'forehead'
a. Singai *ərəʔ*, Seratong *ərəʔ*, Hliboi *iloʔ*, Biatah *ərəʔ*, Tringgus Raya *ərəʔ*
b. Bukar *dəʔih*, Sadong *dəʔih* (PMP *daqih)

(21) Bau-Jagoi-Biatah *kajit 'ear'
a. Singai *kəjit*, Grogo *kəjit*, Hliboi *kijit*, Biatah *kəjit*, Tringgus Raya *kajit*
b. Bukar *kəpiŋ*, Sadong *kəpiŋ* (PB-SLD *kəpiŋ)

(22) Bau-Jagoi-Biatah *siʔen 'to cry'
a. Singai *sien*, Grogo *siʔen*, Hliboi *siʔin*, Biatah *siʔen*, Tringgus Raya *saʔin*
b. Bunan *nəŋis* (PMP taŋis)

(23) Bau-Jagoi-Biatah *(u)tos 'needle'
a. Singai *tos*, Grogo *tos*, Serambu *tos*, Biatah *utos*, Tringgus Raya *tos*
b. Bukar *jarum*, Sadong *jarum* (PMP *zaRum, however, this is a borrowing from Malay since we expect *R > *h*)

APPENDIX II

EVIDENCE FOR HLIBOI AS A BAU-JAGOI LANGUAGE

*u > *a* in reflexes of *uRat 'vein'

(24) Gumbang *aat*, Grogo *aat*, Serambu *aat*, Hliboi *aat*
Biatah *uat*, Bistaang *uat*, Tringgus Bireng *uat*, Bukar *uhat*, Sadong *uhat*

Exclusively shared lexical replacement innovation

(25) Bau-Jagoi *kəjit/ŋəjit 'to listen/hear'
a. Gumbang *ŋəjit*, Grogo *ŋəjit*, Serambu *ŋəjit*, Bratak *kəjit*, Hliboi *ŋijit*
b. Biatah *diŋah*, Tringgus Bireng *dəŋen*, Sadong *kidiŋah* (PMP *dəŋəR)

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