A QUANTITATIVE PHONOLOGY OF MAI BRAT[1]

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Fonologi kuantitatif bahasa Mai Brat

Bahasa Mai Brat adalah salah satu bahasa yang terbesar di Irian Jaya. Bahasa itu digunakan oleh sekitar 22.000 orang. Kebanyakan tinggal di keliling danau Ayamaru di Kabupatan Sorong. Ucapan bahasa Mai Brat gampang bisa dijelaskan dengan teori *CV Phonology* yang diajari oleh Clements dan Keyser (1983) dan Clifton (1987). Menurut teori ini, hanya ada sembilan fonem Kontoid dan lima fonem vokoid. Tidak ada fonem /w/ atau /y/ karena bunyi itu bisa termasuk fonem /u/ dan /i/.

1. INTRODUCTION

This paper is a tentative description of the phonological structure of Mai Brat, a Papuan language in the West Papuan Phylum and Central Bird's Head Family. Ayamaru and Brat are other names commonly used for this language (Grimes 1984:398). This paper focuses on the dialect of Mai Brat spoken in the village of Kambuaya, subdistrict of Ayamaru, district of Sorong, province of Irian Jaya, Indonesia.

Currently there are approximately 22,000 speakers of Mai Brat, about 17,000 of whom live around the Ayamaru Lakes. Many other Mai Brat speakers now reside in the urban areas of Sorong, Teminabuan, Manokwari and Jayapura. Voorhoeve (1975) has described Mai Brat as having nine dialects, although we have so far only been able to determine four. The boundaries of these four generally coincide with the subdistrict boundaries of Ayamaru, Aitinyo, Aifat and Mare.

As indicated by the title, this analysis is a quantitative analysis. Beyond qualitative statements of the phonological structure of Mai Brat, frequencies for many aspects of the structure are provided with discussion. It is hoped that the quantitative aspect will provide additional validity for the analysis and potentially provide new objective tools for use in comparative linguistics. The analysis is based on a subset of the 23,945 words which occur in recorded Mai Brat texts, excluding Indonesian loan words and proper names. The texts come from a variety of discourse types including folklore, narrative and hortatory. The resulting lexical database consists of 1,911 unique words. Frequencies provided for any given phenomena in this paper represent the total number of occurrences of that phenomena in the entire database of unique lexical items.

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A-73:1-27. Pacific Linguistics, The Australian National University, 1991. DOI:*10.15144/PL-A73.1*
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2. STRESS AND THE PHONOLOGICAL WORD

The phonological word (also referred to as the lexical word in this paper) in Mai Brat is the domain of one stress. A word may consist of one to four phonetic syllables. Two-syllable words predominate, as may be seen in Table 1.

TABLE 1

SYLLABLES PER WORD	OCCURRENCE TOTAL	PERCENT
1	235	12.3%
2	1323	69.2%
3	327	17.1%
4	26	1.4%
	1911	

Stress is phonemic and can occur on any syllable of the word. The following contrastive examples demonstrate that stress is phonemic in Mai Brat. Glosses are given in English and Indonesian. Stress is indicated by ' before the stressed syllable.

/'nasom/	['nasom]	you carry	*engkau memikul*
/na'som/	[na'som]	your name is	*engkau bernama*
/'maru/	['maru]	she cuts	*dia (perempuan) memotong*
/ma'ru/	[ma'ru]	lake	*danau*
/'ana/	['anə]	they	*mereka*
/a'na/	[a'na]	fence	*pagar*
/mo'o/	[mo'o]	she itches	*dia (perempuan) gatal*
/'moo/	['moo]	she takes	*dia (perempuan) mengambil*

3. PHONOLOGICAL SYLLABLE

Figure 1 below gives phonemes found in Mai Brat. These segments will be justified later, in section 4.

	CONSONANTALS (C)				NON-CONSONANTALS (V)		
	Bilabial	Alveolar	Velar		-Back -Round	+Back -Round	+Back +Round
Stops	*b*	*t*	*k*	+High	*i*		*u*
Fricatives	*p*	*s*	*x*	-High	*e*		*o*
Nasals	*m*	*n*				*a*	
Flap		*r*					

FIGURE 1

The following syllable analysis uses the model presented by Clements and Keyser (1983). Central to that model is the claim that syllable structure is predictable, once syllable peaks (Vs) and non-peaks (Cs) are identified. In this section, following Clifton (1987), I will claim that all Vs and

Cs are predictable from surrounding segments and stress. The rigorous application of this model will show that there is no need to posit the semivowels /y/ and /w/ as separate underlying phonemes in Mai Brat since their occurrence is completely predictable under CV Phonology. This model also provides an excellent framework for understanding Extrasyllabic and Ambisyllabic segments, both of which are found in Mai Brat as will be discussed later in this section. Mai Brat has the following core phonetic syllable types: CV, V, CVC and VC. Vb sequences are not allowed in Mai Brat syllables as symbolised by the Negative Syllable Structure Condition (NSSC) given below, where the Greek sigma σ represents a single syllable and the distinctive features are those described in section 4.1 below.

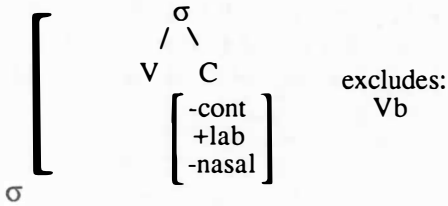
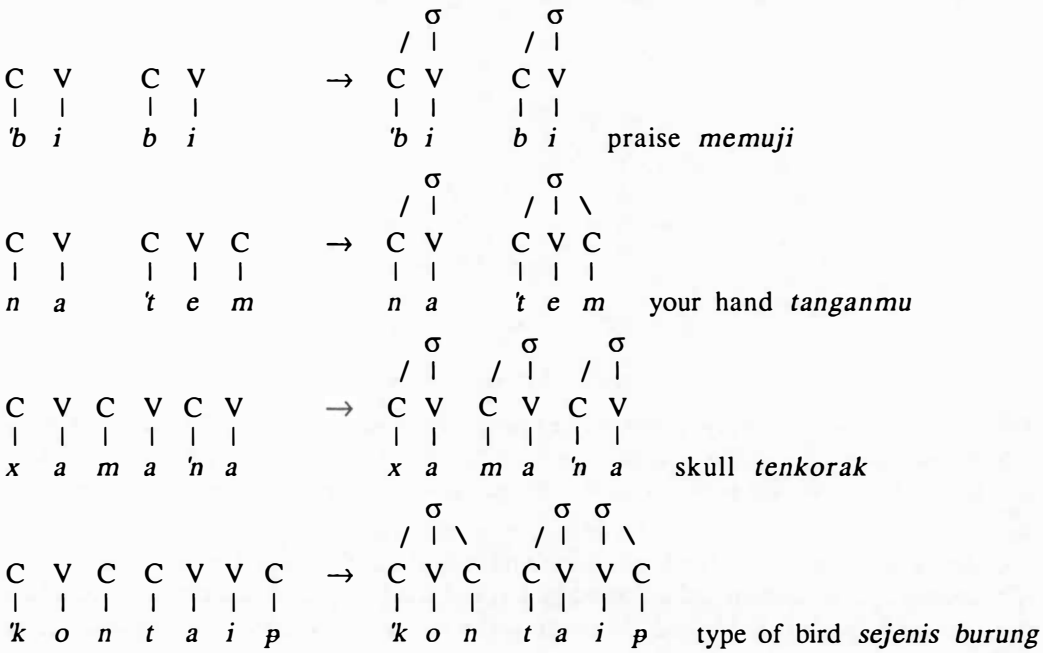


FIGURE 2

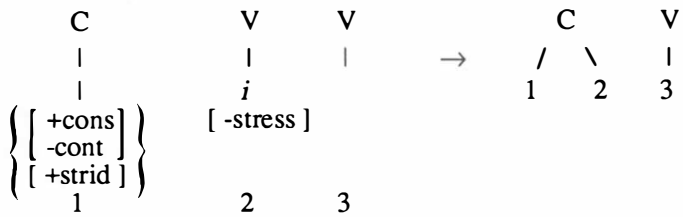
Using Clements and Keyser's interpretation of the 'Onset First Principle' the following examples show that syllabification in Mai Brat is predictable. To begin the process of identifying syllable peaks and non-peaks, all consonantals are assumed to be Cs and all non-consonantals Vs. Each V is then linked to a σ, that is, it forms a syllable peak. C elements to the immediate left of the V are linked to σ which is then followed by C elements that are contiguous on the right side of the V and that do not violate the NSSC in Figure 2. This procedure results in the syllable shapes found in Mai Brat.

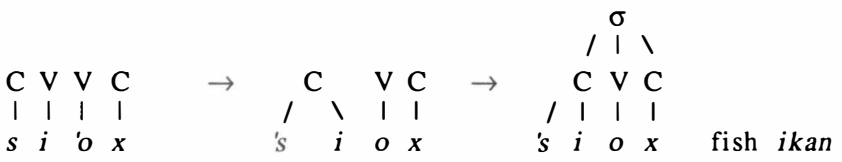


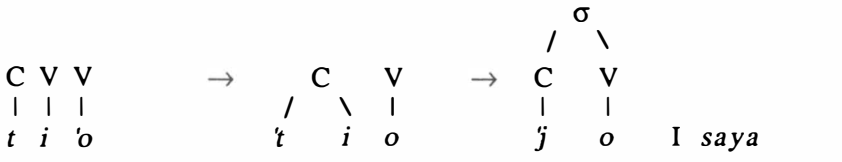
The above syllabification procedure works well as long as the underlying phonemes (lexical representation) have a one-to-one correspondence with the phonetic segments and all non-consonantals correspond to V elements. However, this is not always the case in Mai Brat. CV Phonology gives a framework for dealing with many-to-one and one-to-many correspondences between phonemes and phonetic segments. I will now describe those exceptional cases, which are completely predictable, and give those additional rules that provide proper syllabification. Numbers following rule names indicate the number of times the rule was applied in the syllabification of the data set.

The first three cases have to do with the high segment /i/. These three rules must be applied in the order given. To begin with, in the sequence C V1 V2 where C is either a non-continuant consonantal or a strident /b/, /t/, /k/, /m/, /n/, /s/ and V1 is /i/ and unstressed, C V1 becomes C. Phonetically, the two phonemes coalesce to a palatalised form of the consonant. This rule is symbolised below and is followed by examples.

PALATALISATION (123):



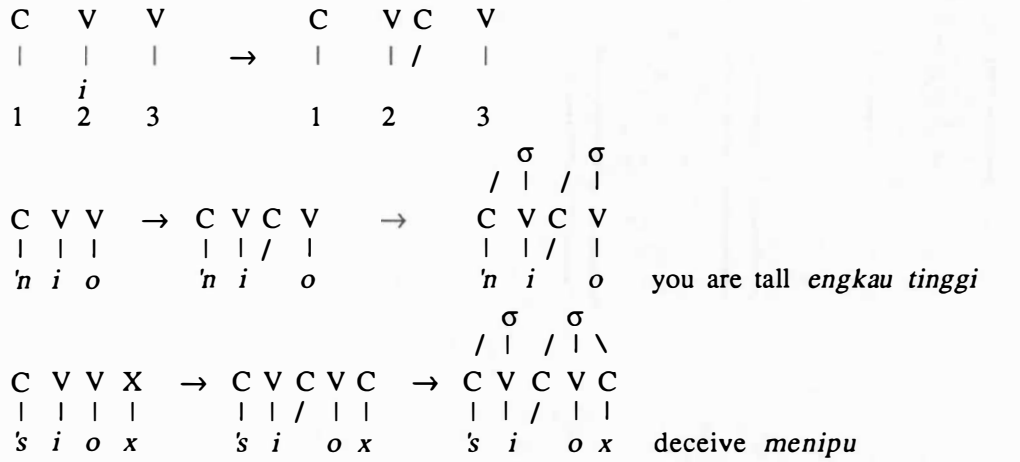




Palatalisation does not apply to forms like /'ririon/ because the /iV/ combination is not preceded by a non-continuant or a strident. It also does not apply in forms like /'nio/ since the /i/ is stressed. It should also be mentioned at this point that the palatalised /t/ frequently becomes the affricate [j].

In the second case, the high segment /i/ is interpreted as an ambisyllabic segment. Clements and Keyser define a segment to be 'ambisyllabic if and only if it is dominated by two nodes σ' (p.58). If /i/ is preceded by a consonant and followed by a vowel it is interpreted as ambisyllabic and functions both as the peak of its syllable and the onset of the following syllable. Phonetically, it becomes [CiyV].

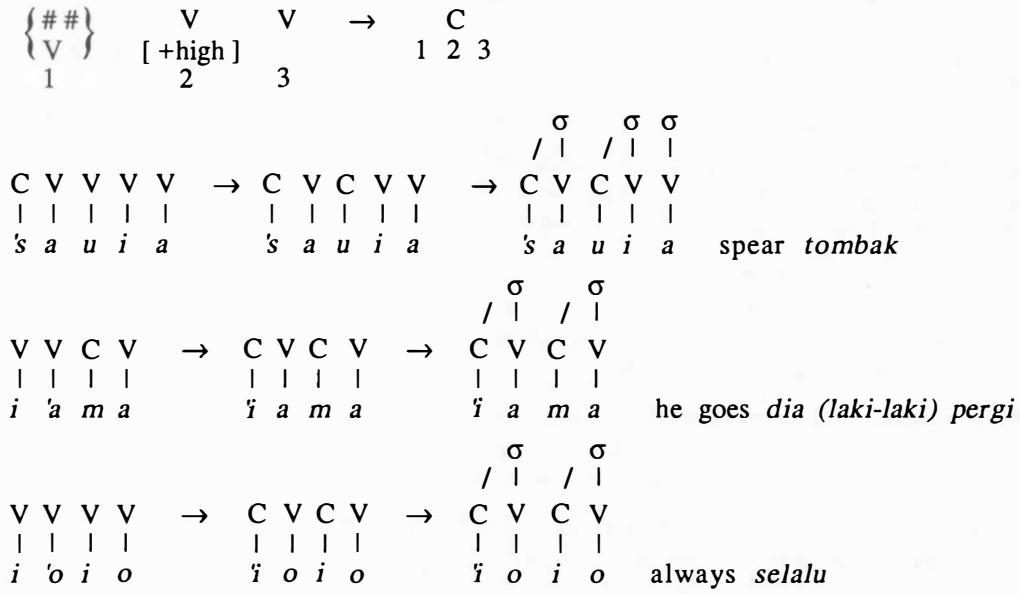
SEMIVOWEL INSERTION (67):



Notice that palatalisation does not occur in these cases since it is blocked by the stress.

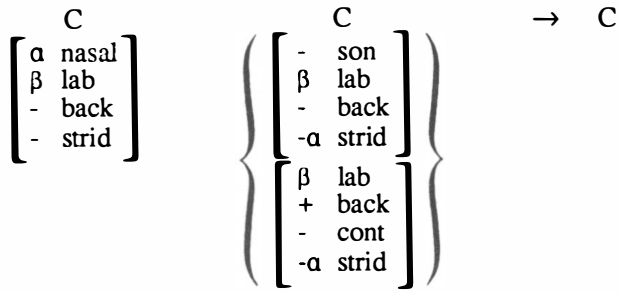
The third case involving the high segment /i/ also involves the other high segment /u/. If a high non-consonantal /i/ or /u/ is not preceded by a consonantal and is followed by a non-consonantal it becomes a C.

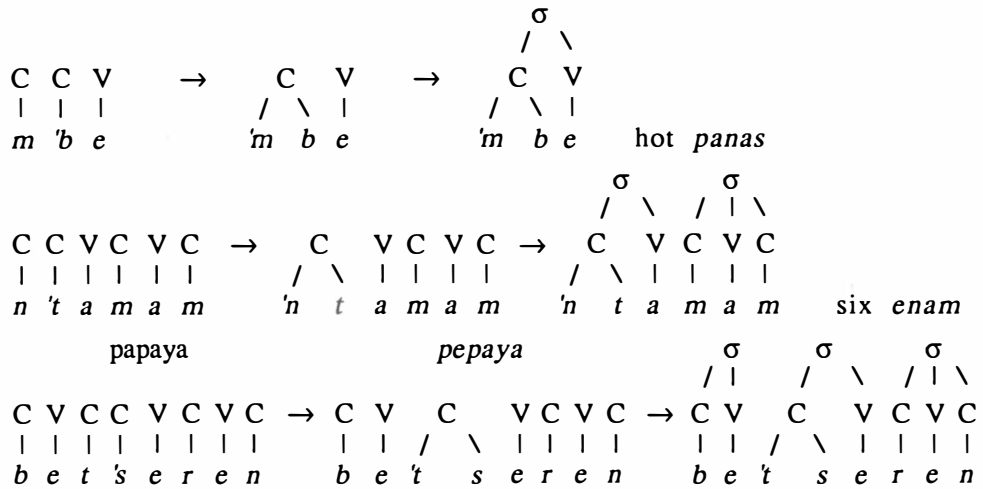
SEMIVOWEL CREATION (330):



The next group affects consonant sequences. The following three rules are ordered and must be applied in the order given. First, some lexical consonantal sequences (CC) predictably regroup to form a single C. The sequences /mb/, /mf/, /nt/, /nk/ and /ts/ undergo this regrouping before syllabification. This is symbolised below.

CONSONANT REGROUPING (182)





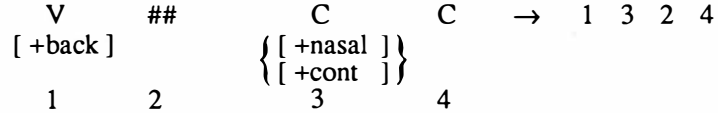
Another process affects 'extrasyllabic consonants'. Clements and Keyser define extrasyllabics in the following way: 'a segment P is extrasyllabic if and only if it is dominated by no node σ' (p.58). In a discussion of extrasyllabics in Turkish and Klamath they state:

> Typically, such (extrasyllabic) consonants are separated from neighboring consonants by short neutral or voiceless vowels and are historically susceptible to processes which either eliminate them or incorporate them into well formed syllables by means of processes such as vowel epenthesis...

These descriptions of extrasyllabic consonants describe a common phenomenon in Mai Brat. There are many consonants that remain unsyllabified upon the application of the preceding syllabification procedure. Those consonants undergo one of two ordered processes.

In the first possible process, word-initial nasal or fricative extrasyllabics tend to shift to form the closure of preceding words ending in back vowels /a/, /o/ or /u/.

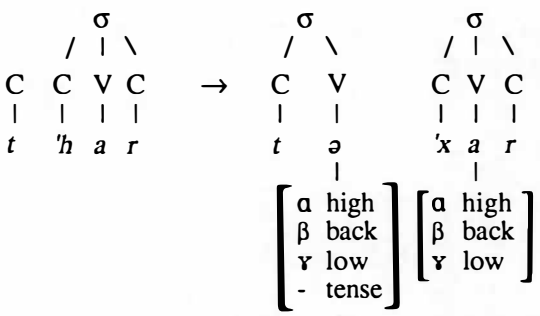
CODA CREATION:



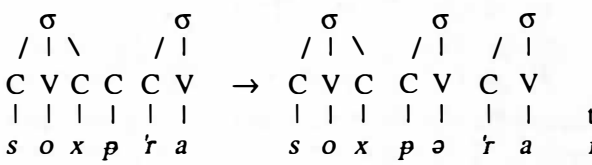
plank *papan*

In the second process, extrasyllabics before a syllabified C become separated from that C through the epenthesis of a short neutral vowel [ə], [ɪ] or [ɛ]. Although this lax epenthetic vowel is phonetically most frequently [ə] it may reflect the vowel quality of the next vowel in the word resulting in [ɪ] or [ɛ]. A new syllable is then formed with the previously extrasyllabic consonant becoming the onset and the epenthetic vowel the peak.

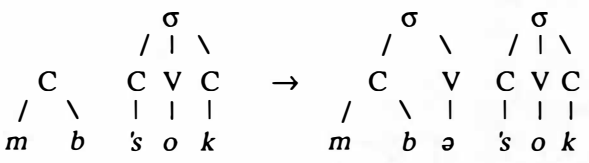
EPENTHESIS (472):



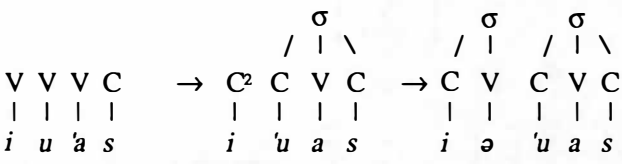
I know *saya tahu*



traditional house for skulls
rumah adat untuk tengkorak[2]



slippery *licin*



he is making a fence
ia (laki-laki) memagari

See sections 3.1 and 4.2.1 for information on CCC clusters.

There remain three additional phenomena in Mai Brat syllabification that need to be presented. Like Coda Creation, each of these operate across word boundaries and may be viewed as resyllabification rules. Resyllabification, in this context, implies that after a segment is added or shifts across a word boundary the words involved need to go through the syllabification process again. These three rules all result in providing a C onset for words beginning with a vowel.

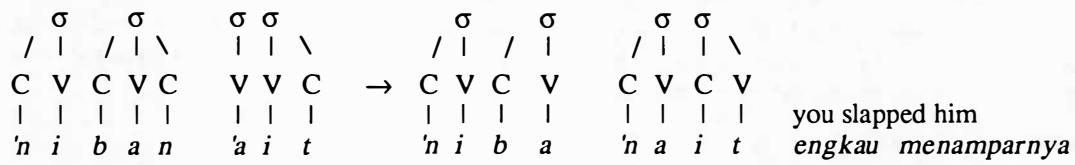
In the first rule, a word-final non-continuant /m/, /t/, /n/ or /k/ shifts to the beginning of the following word beginning with a Vowel.

NON-CONTINUANT ONSET CREATION:

V C ## V → 1 3 2 4

[-cont]

1 2 3 4



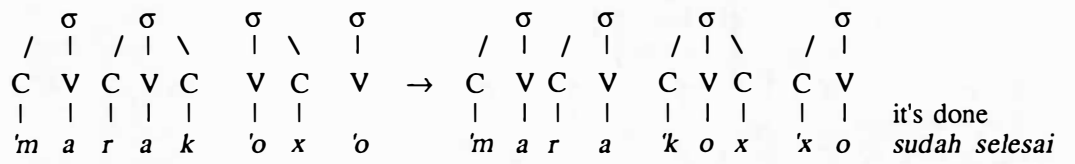
In the second rule, a word-final continuant /ɸ/, /s/, /r/ or /x/ reduplicates with the new C becoming the onset of the following word beginning with a V.

CONTINUANT ONSET CREATION:

V C ## V → 1 2 3 2 4

[+cont]

1 2 3 4



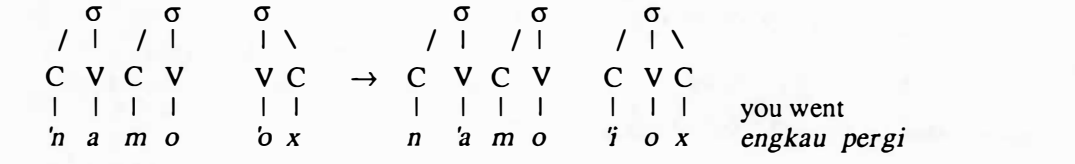
In the third and final rule, when a word beginning with /o/ is preceded by a word ending in an /o/ the second word receives a C onset filled by an /i/. This phenomenon does not occur with any other V combination.

SEMIVOWEL ONSET CREATION:

V ## V → 1 2 C 3

[- high, +round] [- high, +round] [- cons, +high, - back]

1 2 3



3.1 LEXICAL SHAPES

In the following discussion, the term 'lexical shape' corresponds to the phonological representation of words or portions of words prior to the application of the preceding syllabification rules. As was seen above, the lexical shapes of words in Mai Brat often do not coincide with phonetic syllable structure. It does appear, however, that all lexical words may be constructed from one or more combinations of basic lexical shapes. Those basic shapes include V, VC, CV, CVC, CCV, CCVC, CCCV and CCCVC. See section 4.2.1 for a discussion of restrictions on CCC sequences. Each of these shapes may occur in isolation as demonstrated below or in combination with other shapes, up to five shapes per lexical word.

V	/'a/	['a]	interrogative	*kah*
VC	/'ax/	['ax]	frog	*kodok*
CV	/'ɒe/	['ɒe]	not	*tidak*
CVC	/'max/	['max]	difficult	*sulit*
CCV	/ɒ'ra/	[ɒə.'ra]	rock	*batu*
	/m'ɒe/	['^{m}ɒe]	no	*tidak*
CCVC	/m'bin/	['^{m}bin]	dull	*tumpul*
	/t'har/	[tə.'har]	I know	*saya tahu*
CCCV	/nk'mo/	[^{ŋ}kə.'mo]	you're angry	*engkau marah*
CCCVC	/mɒ'rok/	[^{m}ɒə.'rok]	she came out	*dia (perempuan) keluar*

The Tables 2-6 give the number of times each lexical shape was found in the database by position and word length. Table 7 gives the total frequencies of all basic lexical shapes independent of position or word length.

TABLE 2
WORDS HAVING ONE LEXICAL SHAPE
(547 words or 28.6% of the database)

LEXICAL SHAPE	OCCURRENCE TOTAL	PERCENT
V	3	0.5%
VC	10	1.8%
CV	34	6.2%
CVC	101	18.5%
CCV	119	21.8%
CCVC	236	43.1%
CCCV	20	3.7%
CCCVC	24	4.4%
Total shapes	547	

TABLE 3
WORDS HAVING TWO LEXICAL SHAPES
(879 words or 46.0% of the database)

LEXICAL SHAPE	S1	S2	OCCURRENCE TOTAL	PERCENT
V	84	112	196	11.1%
VC	8	202	210	11.9%
CV	539	290	829	47.2%
CVC	25	256	281	16.0%
CCV	213	5	218	12.4%
CCVC	4	5	9	0.5%
CCCV	5	8	13	0.7%
CCCVC	1	1	2	0.1%
Total shapes			1758	

TABLE 4
WORDS HAVING THREE LEXICAL SHAPES
(398 words or 20.8% of the database)

LEXICAL SHAPE	S1	S2	S3	OCCURRENCE TOTAL	PERCENT
V	153	220	109	482	40.4%
VC	4	10	108	122	10.2%
CV	197	161	107	465	38.9%
CVC	11	4	74	89	7.5%
CCV	30	3	0	33	2.8%
CCVC	1	0	0	1	0.1%
CCCV	2	0	0	2	0.2%
CCCVC	0	0	0	0	0.0%
Total shapes				1194	

TABLE 5
WORDS HAVING FOUR LEXICAL SHAPES
(82 words or 4.3% of the database)

LEXICAL SHAPE	S1	S2	S3	S4	OCCURRENCE TOTAL	PERCENT
V	36	68	55	41	200	61.0%
VC	0	3	0	26	29	8.8%
CV	37	11	27	11	86	26.2%
CVC	1	0	0	4	5	1.5%
CCV	8	0	0	0	8	2.4%
CCVC	0	0	0	0	0	0.0%
CCCV	0	0	0	0	0	0.0%
CCCVC	0	0	0	0	0	0.0%
Total shapes					328	

TABLE 6
WORDS HAVING FIVE LEXICAL SHAPES
(5 words or 0.3% of the database)

LEXICAL SHAPE	S1	S2	S3	S4	S5	OCCURRENCE TOTAL	OCCURRENCE PERCENT
V	5	4	4	5	3	21	84.0%
VC	0	1	0	0	1	2	8.0%
CV	0	0	1	0	1	2	8.0%
CVC	0	0	0	0	0	0	0.0%
CCV	0	0	0	0	0	0	0.0%
CCVC	0	0	0	0	0	0	0.0%
CCCV	0	0	0	0	0	0	0.0%
CCCVC	0	0	0	0	0	0	0.0%
Total shapes						25	

TABLE 7
ALL WORDS COMBINED
Total number of words = 1911
Average number of shapes per word = 2.0

LEXICAL SHAPE	OCCURRENCE TOTAL	OCCURRENCE PERCENT
V	902	23.4%
VC	373	9.7%
CV	1416	36.8%
CVC	476	12.4%
CCV	378	9.8%
CCVC	246	6.4%
CCCV	35	0.9%
CCCVC	26	0.7%
Total shapes	3852	

A number of observations concerning basic lexical shapes in Mai Brat may be made from Tables 2-7. To begin with, CV shapes predominate comprising 36.8% of the shapes, followed next by V shapes at 23.4%. Lexical shapes beginning with CCC are rare, totalling less than 2% of the database.

Next, there is a correlation between the frequency of occurrence of some shapes and word length. For example, the percentage of occurrence of the shape V steadily increases as word length increases. Also, with the exception of CV and VC in single shape words, the occurrence percentage of all non-V shapes tends to steadily decrease as word length increases.

Finally, some generalisations may be made concerning lexical shapes and their position within words. Table 8 summarises the occurrence of lexical shapes initially, medially and finally for non-single shape words. In general, shapes having a final C occur considerably more frequently word finally than in other positions. The percentage of medial slots filled by a V is three times that of initial

or final positions. Lastly, shapes beginning with a C and ending with a V tend to occur more frequently initially than in other positions.

TABLE 8

LEXICAL	INITIALLY		MEDIALLY		FINALLY	
SHAPE	TOTAL	PERCENT	TOTAL	PERCENT	TOTAL	PERCENT
V	278	20.4%	356	61.7%	265	19.4%
VC	12	0.9%	14	2.4%	337	24.7%
CV	773	56.7%	200	34.7%	409	30.0%
CVC	37	2.7%	4	0.7%	334	24.5%
CCV	251	18.4%	3	0.5%	5	0.4%
CCVC	5	0.4%	0	0.0%	5	0.4%
CCCV	7	0.5%	0	0.0%	8	0.6%
CCCVC	1	0.1%	0	0.0%	1	0.1%
Total shapes	1364		577		1364	

3.2 PHONETIC SYLLABLES

Section 3.1 discussed the basic lexical shapes found in Mai Brat lexical words, and their distribution. Section 3.2 will in turn discuss the phonetic syllables that result upon applying the syllabification procedures given in Section 3 to the lexical word database. As mentioned in Section 3, there are four phonetic syllable types in Mai Brat V, VC, CV and CVC. Phonetically a word may have from one to four syllables. Examples of single syllable words for each of these types are given below.

V	/'o/	['o]	and/or	*dan/atau*
VC	/'ox/	['ox]	past tense marker	*sudah*
CV	/'si/	['si]	needle	*jarum*
	/i'u/	['yu]	woven bag	*noken*
	/ni'o/	['nʸɨ]	you	*engkau*
	/m'ꝑi/	['ᵐꝑi]	like	*seperti*
CVC	/'ꝑos/	['ꝑos]	wind	*angin*
	/u'er/	['wɛr]	very	*sekali*
	/bi'ox/	['bʸox]	enemy	*musuh*
	/m'box/	['ᵐbox]	white	*putih*

The Tables 9-12 give the number of times each syllable was found in the database by position and word length. Table 13 gives the total frequencies of all phonetic syllables independent of position or word length.

TABLE 9
ONE SYLLABLE WORDS
(235 words or 12.3% of the database)

SYLLABLE SHAPE	OCCURRENCE TOTAL	PERCENT
V	3	1.3%
VC	10	4.3%
CV	62	26.4%
CVC	160	68.1%
Total	235	

TABLE 10
TWO SYLLABLE WORDS
(1323 words or 69.2% of the database)

SYLLABLE SHAPE	S1	S2	OCCURRENCE TOTAL	PERCENT
V	69	66	135	5.1%
VC	8	93	101	3.8%
CV	1210	537	1747	66.0%
CVC	36	627	663	25.1%
Total			2646	

TABLE 11
THREE SYLLABLE WORDS
(327 words or 17.1% of the database)

SYLLABLE SHAPE	S1	S2	S3	OCCURRENCE TOTAL	PERCENT
V	15	11	59	85	8.7%
VC	4	0	72	76	7.7%
CV	291	309	122	722	73.6%
CVC	17	7	74	98	10.0%
Total				981	

TABLE 12
FOUR SYLLABLE WORDS
(26 words = 1.4% of the database)

SYLLABLE SHAPE	S1	S2	S3	S4	OCCURRENCE TOTAL	PERCENT
V	0	1	7	3	11	10.6%
VC	0	0	1	6	7	6.7%
CV	26	25	18	11	80	76.9%
CVC	0	0	0	6	6	5.8%
Total					104	

TABLE 13
ALL WORDS COMBINED
Total number of words = 1911
Average number of syllables / word = 2.1

SYLLABLE SHAPE	OCCURRENCE TOTAL	PERCENT
V	234	5.9%
VC	194	4.9%
CV	2611	65.8%
CVC	927	23.4%
Total	3966	

Tables 9-13 provide objective data for several observations concerning the distribution of phonetic syllables in Mai Brat. First, from Table 13 CV syllables predominate filling 65.8% of the syllable slots. The second most common syllable is CVC at 23.4%.

Second, Tables 9-12 show a correlation between word length and the distribution of syllables. The percentage of open syllables (V and CV) increases as the number of syllables in the words increase. Then also, the percentage of CVC syllables steadily decreases as word length increases. From this data there seems to be no direct correlation between frequency of VC syllables and word length.

Third, Table 14 below shows the quantitative relationship between syllable type and relative position in non-monosyllabic words. CV syllables overwhelmingly dominate initial and medial positions filling over 90% of each. It may also be significant that the entire distribution of the various syllable types for initial syllables is almost identical to that found for medial syllables. However, final syllables have a very different distribution than that found in non-final syllables. Closed syllables (VC and CVC) are much more frequent in final syllables than other positions. These facts indicate that for Mai Brat a three way distinction for syllable positions is not necessary. The two way distinction between final and non-final syllables better represents the generality presented in Table 14.

TABLE 14

SYLLABLE SHAPE	INITIALLY TOTAL	PERCENT	MEDIALLY TOTAL	PERCENT	FINALLY TOTAL	PERCENT
V	84	5.0%	19	5.0%	128	7.6%
VC	12	0.7%	1	0.3%	171	10.2%
CV	1527	91.1%	352	92.9%	670	40.0%
CVC	53	3.2%	7	1.8%	707	42.2%
Total	1676		379		1676	

Fourth, comparing Table 13 with Table 7 demonstrates some net effects of the syllabification procedures. Primarily, the totals for V initial units decreased while the totals for C initial units increased. The average number of units per word increased only slightly from 2.0 lexical shapes per word to 2.1 phonetic syllables per word.

4. PHONEMIC SEGMENTS

The dialect of Mai Brat spoken in Kambuaya has nine consonantal phonemes /b/, /t/, /k/, /ᵽ/, /s/, /x/, /m/, /n/ and /r/ and five non-consonantal phonemes /i/, /e/, /u/, /o/ and /a/. The following table gives the phoneme counts for the data used in this analysis:

TABLE 15

Consonant	*b*	*ᵽ*	*m*	*t*	*n*	*s*	*r*	*k*	*x*
Count	369	257	774	695	574	485	468	401	326
Vowel	*i*	*e*	*u*	*o*	*a*				
Count	935	537	519	712	1244				

Total consonants	= 4349	Total vowels	=	3947
Total phonemes	= 8296	Ratio of C:V	=	1.1:1
Total words	= 1911	Average phonemes per word	=	4.3
Total phonemes				

4.1 DISTINCTIVE FEATURES

	b	*ᵽ*	*m*	*t*	*n*	*s*	*r*	*k*	*x*
Sonorant	-	-	+	-	+	-	+	-	-
Consonantal	+	+	+	+	+	+	+	+	+
Continuant	-	+	-	-	-	+	+	-	+
Nasal	-	-	+	-	+	-	-	-	-
Labial	+	+	+	-	-	-	-	-	-
High	-	-	-	-	-	-	-	+	+
Back	-	-	-	-	-	-	-	+	+
Strident	-	-	-	-	-	+	-	-	-

CHART 1

The feature labial was chosen in place of the two features anterior and coronal since only a binary point of articulation feature is needed in Mai Brat. The feature high is not needed to distinguish consonant phonemes, however it is included for use in the phonological rules.

	i	*e*	*a*	*u*	*o*
High	+	-	-	+	-
Back	-	-	+	+	+
Round	-	-	-	+	+

CHART 2

4.2 CONSONANT DESCRIPTION

The following is a list and description of all the consonants with representative examples.

NON-CONTINUANT NON-NASALS

/b/ Labial non-continuant non-nasal (voiced bilabial stop):

/bu'ba/	[bu'ba]	fly	*lalat*
/m'box/	['ᵐbox]	white	*putih*
/a'bit/	[a'bit]	banana	*pisang*
/bomb'ra/	[boᵐbə'ra]	all things	*segala sesuatu*

It is of interest to note that there is not a voiceless allophone of the voiced bilabial stop in the dialect of Mai Brat used in Kambuaya.

/t/ Non-back non-labial non-continuant non-nasal (voiceless alveolar stop):

/'tuƥ/	['tuƥ]	three	*tiga*
/'maat/	['maat]	five	*lima*
/'titia/	['tijə]	when?	*kapan?*
/t'ƥo/	[tə'ƥo]	knife	*pisau*
/'betrot/	['bɛtərot]	to straighten	*meluruskan*

Alveolar stop /t/ become voiced [d] following /n/:

/n'tamam/	['ⁿdamam]	six	*enam*
/nt'rot/	[ⁿdə'rot]	straight	*lurus*
/kon'taiƥ/	[ko'ⁿdaiƥ]	type of bird	*semacam burung*

/k/ Back non-continuant non-nasal (voiceless velar stop):

/ku'kek/	[ku'kɛk]	children	*anak anak*
/k'bor/	[kə'bor]	lower back	*belakan*
/m'kek/	[mə'kɛk]	red	*merah*

Velar stop /k/ becomes voiced [g] before /i/ or after /n/:

/'ki/	['gi]	echidna (small anteater)	*landak*
/kini'ax/	[gi'nʸax]	small	*kecil*
/so'ki/	[so'gi]	machete	*parang*
/boki'as/	[bo'gʸas]	story	*cerita*
/n'kat/	['ŋgat]	wild nutmeg tree	*pala hutan*
/nk're/	[ŋgə're]	stem	*tangkai*
/unk'nu/	[uŋgə'nu]	sky	*langit*

NASALS

/m/ Labial nasal (voiced bilabial nasal):

/'mam/	['mam]	in	*di*
/a'max/	[a'max]	house	*rumah*
/ta'bam/	[ta'bam]	land	*tanah*
/m'bin/	['ᵐbin]	dull	*tumpul*
/'kombox/	['koᵐbox]	small lizard	*cicak kecil*

/n/ Non-labial nasal (voiced alveolar nasal):

/n'tamam/	[ⁿdamam]	six	*enam*
/maui'an/	[maui'an]	hair	*rambut*
/kon'taiɸ/	[ko'ⁿdaiɸ]	type of bird	*semacam burung*
/ka'nes/	[ka'nɛs]	type of bamboo	*bambu jawa*
/kini'ax/	[gi'nʸax]	small	*kecil*

Non-labial nasal /n/ becomes velar [ŋ] before velar /k/:

/n'karu/	['ŋgaru]	erase	*menghapuskan*
/nk'ro/	[ŋgə'ro]	follow	*mengikuti*
/'sankaf/	['saŋgaf]	sky	*langit*

CONSONANTAL CONTINUANTS

/ɸ/ Labial consonantal continuant (voiceless bilabial fricative):

/ɸa'ne/	[ɸa'ne]	pig	*babi*
/'moɸ/	['moɸ]	good	*baik*
/'saɸto/	['saɸto]	rob	*rampas*
/'saɸom/	['saɸom]	green	*hijau*
/m'ɸe/	['ᵐɸe]	no	*tidak*
/soxɸ'ra/	[soxɸə'ra]	skull house	*rumah tengkorak*

/s/ Strident non-labial consonantal continuant (voiceless alveolar grooved fricative):

/'sasu/	['sasu]	sweet potato	*petatas*
/'ɸos/	['ɸos]	wind	*angin*
/s'rot/	[sə'rot]	quickly	*dengan cepat*
/isi'ar/	[i'sʸar]	flood	*banjir*

/r/ Non-back non-strident lingual consonantal continuant (voiced alveolar flap):

/'raa/	['raa]	person	*orang*
/'rir/	['rir]	lightning	*kilat*
/re're/	[re're]	later	*sebentar*
/m'kair/	[mə'kair]	bad, dirty	*jelek, kotor*
/sor'ni/	[sor'ni]	forget	*lupa*
/b'ron/	[bə'ron]	bamboo	*bambu*
/'sentri/	['sentəri]	disagree	*bertanding*

/x/ Back consonantal continuant (voiceless velar fricative):

/'xox/	['xox]	short of breath	*sesak napas*
/soxɸ'ra/	[soxɸə'ra]	skull house	*rumah tengkorak*
/'xaue/	['xawe]	don't want to	*tidak mau*
/x'ri/	[xə'ri]	day	*hari*

4.2.1 CONSONANT SEQUENCES

The following four tables give the number of occurrences of all consonant clusters found initially and medially in the data. The rows specify the first consonants in the clusters and the columns specify the second consonants. Asterisks mark those clusters which undergo consonant regrouping. All other clusters involve epenthetic vowels. See section 3 for a discussion of these phenomena. No final consonant clusters are found in Mai Brat.

TABLE 16

INITIAL CLUSTERS OF TWO CONSONANTS

	b	*ƥ*	*m*	*t*	*n*	*s*	*r*	*k*	*x*	Total
b	0	6	7	5	2	6	12	4	5	47
ƥ	0	0	0	3	1	0	10	1	0	15
m	46 *	20 *	8	23	12	24	14	13	16	176
t	7	5	5	2	10	7 *	9	7	7	59
n	9	8	10	41 *	2	32	8	17 *	13	140
s	9	1	10	1	7	0	13	6	1	48
r	0	0	0	0	1	0	0	1	0	2
i[2]	14	9	7	6	6	17	8	11	14	92
k	5	0	3	1	5	1	6	0	0	21
x	0	0	1	1	1	0	8	0	0	11
Total	90	49	51	83	47	87	88	60	56	611

TABLE 17

MEDIAL CLUSTERS OF TWO CONSONANTS

	b	*ƥ*	*m*	*t*	*n*	*s*	*r*	*k*	*x*	Total
b	0	0	0	1	0	0	7	0	0	8
f	0	0	0	1	1	0	8	0	0	10
m	6 *	1 *	0	2	0	1	0	1	0	11
t	3	1	7	0	2	5 *	11	2	1	32
n	0	0	0	7 *	0	3	1	2 *	1	14
s	5	0	2	1	5	0	5	4	2	24
r	2	2	4	1	3	0	0	2	0	14
k	3	0	3	1	3	3	14	0	0	27
x	0	2	3	0	4	2	5	0	0	16
Total	19	6	19	14	18	14	51	11	4	156

TABLE 18

INITIAL CLUSTERS OF THREE CONSONANTS

	b	*f*	*m*	*t*	*n*	*s*	*r*	*k*	*x*	Total
bx	0	0	0	0	0	0	1	0	0	1
bt	0	0	0	0	0	1 *	0	0	0	1
*mb**	0	0	0	1	0	0	5	0	0	6
*mf**	0	0	0	0	0	0	3	0	0	3
mt	1	0	0	0	0	0	0	0	0	1
mk	0	0	0	1	0	0	0	0	0	1
mx	0	0	0	0	0	0	1	0	0	1

Table 18 continued...

...Table 18 continued

	b	*f*	*m*	*t*	*n*	*s*	*r*	*k*	*x*	Total
tf	0	0	0	0	0	0	1	0	0	1
*ts**	0	0	0	0	2	0	0	0	0	2
tk	0	0	0	0	0	0	2	0	0	2
tx	0	0	0	0	0	0	1	0	0	1
nf	0	0	0	0	0	0	1	0	0	1
*nt**	2	1	1	0	1	0	4	2	0	11
ns	0	0	0	0	1	0	0	4	1	6
*nk**	0	0	2	0	2	1	8	0	0	13
kt	0	0	1	0	0	0	0	0	0	1
Total	3	1	4	2	6	2	27	6	1	52

TABLE 19

MEDIAL CLUSTERS OF THREE CONSONANTS

	n	*r*	Total
*mb**	0	2	2
*mf**	0	1	1
*ts**	0	2	2
*nt**	0	3	3
*nk**	1	0	1
xf	1	1	2
Total	2	9	11

Tables 16 and 17 demonstrate that all Mai Brat consonants may appear in the initial or final position of two-consonant sequences. However, in word-initial sequences of three consonants (Table 18) there appear to be restrictions on which consonants may fill certain positions. To begin with, only non-continuants are found in the initial consonant position. Secondly, only non-sonorants are present in the second consonant position. Thirdly there are no positional restrictions on which consonants may fill the sequence final slots as all consonants are found in that position. Finally, the non-nasal sonorant /r/ is predominant in the final position of both initial and medial sequences of three consonants. /r/ fills 57% of these positions while only accounting for 11% of all consonants.

Table 20 gives all two-consonant sequences that never occur in Mai Brat in any position.

TABLE 20

	b	*p*	*s*	*r*	*k*	*x*
b	X					
p	X	X	X			X
s			X			
r			X	X		X
k		X			X	X
x	X				X	X

4.2.2 CONTRASTIVE SETS OF CONSONANTS

The following contrastive sets are presented with sample minimal pairs from the data. The total number of minimal pairs found for each consonant pair is given in parenthesis following the heading

for that pair. The consonant pairs themselves are grouped by the single distinctive feature that distinguishes them. Statistics of this kind may give an objective measure of the functional load for each distinctive feature in a given language. These statistics as well as others presented in this paper may also be helpful in language and dialectal comparisons.

CONTINUANT VERSUS NON-CONTINUANT (145)

/ɸ/ and /b/ (36):

/'ɸox/	['ɸox]	quickly	*dengan cepat*
/'box/	['box]	ashes	*abu*
/a'ɸan/	[a'ɸan]	termite	*rayap*
/a'ban/	[a'bən]	snake	*ular*

/r/ and /t/ (68):

/'ru/	['ru]	bird	*burung*
/'tu/	['tu]	must	*harus*
/'marak/	['marak]	there isn't any	*tidak ada*
/'matak/	['matak]	solid, hard	*kuat, keras*
/'bur/	['bur]	bee	*lebah*
/'but/	['but]	leach	*lintah*

/x/ and /k/ (41):

/'xox/	['xox]	short of breath	*sesak napas*
/'kox/	['kox]	soil	*tanah*
/'kok/	['kok]	chicken	*ayam*
/'naxox/	['naxox]	you hit	*engkau memukul*
/'nakox/	['nakox]	you carry things in a woven bag hung on your head	*memikul noken diatas kepalamu*
/m'kax/	[mə'kax]	they work on	*mereka mengerjakan*
/m'kak/	[mə'kak]	all gone	*habis*

NASAL VERSUS NON-NASAL (228)

/m/ and /b/ (93):

/'mun/	['mun]	time	*kali*
/'bun/	['bun]	squash	*labu*
/'ramu/	['ramu]	our	*kami punya*
/'rabu/	['rabu]	morning	*pagi*

/n/ and /t/ (135):

/na'a/	[na'a]	your leg	*kakimu*
/ta'a/	[ta'a]	my leg	*kakiku*

/na'na/	[na'nə]	your head	*kepalamu*
/na'ta/	[na'tə]	you drink	*engkau minum*
/a'ban/	[a'ban]	snake	*ular*
/a'bat/	[a'bat]	non-decorated (woven bag)	*(noken yang) tidak berhinas*

STRIDENT VERSUS NON-STRIDENT (58)

/s/ and /r/ (58):

/'si/	['si]	needle, nail	*jarum, paku*
/'ri/	['ri]	glue used to catch birds	*getah untuk menangkap burung*
/i'so/	[i'so]	road, trail	*jalan*
/i'ro/	[i'ro]	wrong doing	*dosa*
/m'ras/	[mə'ras]	they pound a sharp edge on a machete	*mereka mengetuk parang sampai tajam*
/m'rar/	[mə'rar]	chin	*dagu*

LABIAL VERSUS NON-LABIAL (172)

/m/ and /n/ (172):

/'nam/	['nam]	you are jealous	*engkau iri hati*
/'mam/	['mam]	in	*di*
/'nan/	['nan]	connect	*memasang*
/'anu/	['anu]	we (inclusive), you (pl)	*kita, kamu*
/'amu/	['amu]	we (exclusive)	*kami*
/'ꝑon/	['ꝑon]	thinly woven string	*tali kecil*
/'ꝑom/	['ꝑom]	type of insect	*semacam serangga*

BACK VERSUS NON-BACK (64)

/k/ and /t/ (64):

/'kait/	['kait]	to him	*kepadanya*
/'tait/	['tait]	centipede	*kaki seribu*
/m'ki/	[mə'gi]	it scrapes	*menggores*
/m'ti/	[mə'ti]	night, dark	*malam, gelap*
/a'buk/	[a'buk]	small lizard	*cecak*
/a'but/	[a'but]	suddenly	*tiba-tiba*

OTHER CONTRASTS

/t/ and /s/ (88):

/'tan/	['tan]	wood used to burn a garden	*kayu yang dipergunakan untuk membakar kebun*
/'san/	['san]	type of food	*semacam makanan*

/'nato/	['nato]	your liver	*hatimu*
/'naso/	['naso]	you plant taro	*engkau menanam keladi*
/'kaut/	['kaut]	mouse	*tikus*
/'kaus/	['kaus]	boil	*bisul*

4.3 VOWEL DESCRIPTION

The following is a list and description of all the vowels with representative examples. See also section 3 for a discussion of the non-syllabic allophones of the high syllabics /i/ and /u/.

NON-BACK SYLLABICS

/i/ High non-back syllabic (high front unrounded vowel):

/'iɒo/	['iɒo]	today	*hari ini*
/'iis/	['iis]	yesterday	*kemarin*
/'bisir/	['bisir]	drunk	*mabuk*
/s'ki/	[sɪ'gi]	build (a house)	*membangun (rumah)*
/ma'bi/	[ma'bi]	old, large	*tua, besar*

/e/ Non-high non-back syllabic (mid front unrounded vowel):

/'euok/	['ewok]	two	*dua*
/'et/	['ɛt]	warning sign	*tanda bahaya*
/re're/	[re're]	later	*sebentar*
/sa'ɒe/	[sa'ɒe]	black	*hitam*
/'tee/	['tee]	I give	*saya memberi*

The vowel /e/ becomes lax [ɛ] as the peak of word-final closed syllables:

/'men/	['mɛn]	blood-letting	*mengiris kulit untuk keluarkan darah mati*
/'romen/	['romɛn]	animal trail	*jalan binatang*
/m'ber/	['ᵐbɛr]	she teaches	*dia (perempuan) mendidik*
/s'xex/	[sə'xɛx]	type of fungal skin disease	*kaskado*

BACK SYLLABICS

/a/ Non-high back unrounded syllabic (low central unrounded vowel):

/a'ta/	[a'ta]	crayfish	*udang karang*
/a'ken/	[a'kɛn]	canoe	*perahu*
/'ɒakot/	['ɒakot]	yawn	*menguap*
/'mam/	['mam]	in	*di*
/'maam/	['maam]	edge	*pingir*
/'tatia/	['tajə]	my father	*ayahku*

Word-final /a/ becomes lax [ə] in unstressed syllables:

/'auia/	['auiə]	who	*siapa*
/su'ara/	[su'arə]	tapioca root	*kasbi*
/'ana/	['anə]	they	*mereka*
/'tatia/	['tajə]	my father	*bapakku*

/u/ High back syllabic (high back rounded vowel):

/'u/	['u]	above	*di atas*
/'uu/	['uu]	again	*lagi*
/'tuƥ/	['tuƥ]	three	*tiga*
/'kaus/	['kaus]	boil	*bisul*
/'namu/	['namu]	your uncle	*pamanmu*
/'rabu/	['rabu]	morning	*pagi*

/o/ Non-high rounded back syllabic (mid back rounded vowel):

/'oot/	['oot]	saliva	*ludah*
/'soon/	['soon]	coconut	*kelapa*
/'kombox/	['kombox]	type of lizard	*cecak kecil*
/'to/	['to]	specifying article	-
/'too/	['too]	I itch	*saya rasa gatal*

Word-final /o/ becomes /i̯/ following an /i/ or palatalised consonant:

/ai'o/	[a'yi̯]	sun	*matahari*
/si'o/	['sʸi̯]	faeces	*tai*
/'mio/	['miyi̯]	long	*panjang*

4.3.1 VOWEL SEQUENCES

The following tables give the vowel sequences found in the Mai Brat data. Tables are given for initial, medial and final positions.

TABLE 21
INITIAL VOWEL CLUSTERS

	i	*e*	*a*	*u*	*o*	Total
i	12	12	75	11	9	119
e	0	1	0	1	0	2
a	4	1	3	5	1	14
u	6	15	31	3	20	75
o	0	0	0	0	2	2
Total	22	29	109	20	32	212

TABLE 22
MEDIAL VOWEL CLUSTERS

	i	*e*	*a*	*u*	*o*	Total
i	11	23	61	22	61	178
e	13	3	4	9	1	30
a	81	1	14	68	2	166
u	36	11	25	15	9	96
o	12	0	4	10	11	37
Total	153	38	108	124	84	507

TABLE 23
FINAL VOWEL CLUSTERS

	i	*e*	*a*	*u*	*o*	Total
i	5	16	51	4	48	124
e	0	3	4	4	0	11
a	26	1	9	34	5	75
u	2	15	15	5	2	39
o	0	0	0	3	13	16
Total	33	35	79	50	68	265

It may be observed from Tables 21-23 that the vowel sequence /oe/ never occurs in Mai Brat. All other sequences occur medially at least.

4.3.2 CONTRASTIVE SETS OF VOWELS

HIGH VERSUS NON-HIGH (128)

/i/ and /e/ (68):

/'min/	['mɪn]	difficult	*sulit*
/'men/	['mɛn]	blood-letting	*mengiris kulit untuk keluarkan darah mati*
/'nari/	['nari]	you hear	*engkau mendengar*
/'nare/	['nare]	your thigh	*pahamu*

/o/ and /u/ (60):

/'mormor/	['mormor]	star	*bintang*
/'murmur/	['murmur]	diligent	*rajin*
/m'so/	[mə'so]	she gathers	*dia mengumpulkan*
/m'su/	[mə'su]	she drowned	*dia tenggelam*

ROUND VERSUS UNROUNDED (137)

/a/ and /o/ (137):

/'ax/	['ax]	frog	*kodok*
/'ox/	['ox]	past tense marker	*sudah*
/n'sam/	[nə'səm]	you run away	*engkau melarikan diri*
/n'som/	[nə'som]	you play	*engkau bermain*
/t'na/	[tə'na]	then	*kemudian*
/t'no/	[tə'no]	I make	*saya membuat*

BACK VERSUS NON-BACK (157)

/i/ and /u/ (73):

/a'bit/	[a'bit]	banana	*pisang*
/a'but/	[a'but]	suddenly	*tiba-tiba*
/'mai/	['mai]	language, voice	*bahasa, suara*
/'mau/	['mau]	(pig) roots	*(babi) menyungkur*

/o/ and /e/ (84):

/'mos/	['mos]	well	*sumur*
/'mes/	['mes]	blood	*darah*
/'nako/	['nako]	you don't want	*tidak mau*
/'nake/	['nake]	your fine	*dendamu*

A minimal set:

/'ri/	['ri]	glue used to catch birds	*getah untuk menangkap burung*
/'re/	['re]	so that	*supaya*
/'raa/	['raa]	person	*orang*
/'ru/	['ru]	bird	*burung*
/'ro/	['ro]	who, which	*yang*

4.4 VOWEL AND CONSONANT CO-OCCURRENCE

All syllabics are found before and after all non-syllabics in all positions with the following exceptions. /xi/ is only found word initially. /fu/ and /ux/ never occur in word-final position. And finally, /xe/ and /ix/ never occur medially.

5. SUGGESTED ORTHOGRAPHY

The following chart summarises the phonemes of the dialect of Mai Brat found in Kambuaya, and a suggested orthography. The suggested orthography was heavily influenced by three factors.

First, where phonetic units found in Mai Brat were also present in Indonesian, the national language, the corresponding Indonesian orthographic symbol was used. For example, the high vowels /i/ and /u/ are written as the semivowels *y* and *w* respectively when syllabified as a C (see Section 3 for the syllabification procedures). This corresponds to the use of the semivowels in Indonesian. Also, the phonetic affricates resulting from the phoneme sequences /ts/ and palatalised /t/ are written orthographically as *c* and *j* respectively as they are in Indonesian. Palatalised consonants are written as the consonant followed by a *y* as the *ny* in Indonesian. Stress is predictable in Indonesian and not written. Most stress pairs in Mai Brat are differentiated by semantic context. We have rarely observed any confusion when stress is not written in Mai Brat using the suggested orthography.

Second, reading difficulties observed when a previous test orthography was used were influential in these orthographic decisions. This was especially important in the treatment of extrasyllabics. In the test orthography the epenthetic [ə] was written as an *e*. That also coincided with the Indonesian treatment of the [ə] in the same position. However, Mai Brat speakers who were very literate in Indonesian read the epenthetic [ə] when symbolised by *e* in their own language as a stressed [e]. This mispronunciation also was accompanied by backtracking, indicating a lack of comprehension. On the other hand, writing the extrasyllabics without symbolising the epenthetic [ə] not only resulted in the proper pronunciation and less backtracking, but has also been well received by those who have encountered it.

Third, data collected from 28 teenagers and adults, literate in the national language, when asked to write words and phrases in Mai Brat, their mother tongue, were also extremely helpful. The majority of extrasyllabics were written without symbolising the epenthetic [ə] even though this frequently resulted in consonant sequences not found in Indonesian. The *j, c, ny* and other C*y* sequences were frequently used.

The last two factors were also very influential in the preceding phonological analysis, as they gave evidence to the psychological reality of the posited phonemes and syllabification procedures.

PHONEME	SUGGESTED ORTHOGRAPHY
b	*b*
p	*f*
m	*m*
t	*t*
n	*n*
s	*s*
r	*r*
k	*k*
x	*h*
i	*i* (when syllabified as a V)
	y (when syllabified as a C)
e	*e*
u	*u* (when syllabified as a V)
	w (when syllabified as a C)
o	*o*
a	*a*
' (stress)	(not written)
CLUSTERS	
t (palatalised)	*j*
n (palatalised)	*ny*
s (palatalised)	*sy*
b (palatalised)	*by*
m (palatalised)	*my*
k (palatalised)	*ky*
ts	*c*

NOTES

1. Research for this paper was carried out under the auspices of the Universitas Cenderawasih – Summer Institute of Linguistics Project beginning in March 1984. Of great assistance to my wife and myself in our research were Julianus Bosawer and Petrus Kambuaya. The use of portable microcomputers was also invaluable in the creating, confirming and editing of the preceding analysis. Comments on this paper, provided by Dr David Payne, Dr Doris Payne, Dr John Clifton and Duane Clouse, were invaluable in producing this phonology. Of course all remaining faults remain the author's responsibility.

2. There is one set of forms that the rules accounting for the syllabicity of /i/ above do not account for, in which a word initial /i/ before a C may also be an extrasyllabic C. For example, /i'tax/ [yə'tax] 'he sharpens' *dia (laki-laki) mempertajam* contrasts with /i'ta/ [i'ta] 'leaf' *daun*. In all cases this extrasyllabic /i/ is the third person masculine singular morpheme. This morpheme occurred 95 times in the database including three times before /u/s which syllabify as consonants.

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