Eastern Cham as a Tone Language[1]

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1. The Cham in Ethnolinguistic Context

The Cham have been surrounded by Austroasiatic-speaking peoples on the Indochina peninsula for at least a couple of millenia. Some writers have therefore grouped Cham with Mon-Khmer (Schmidt 1907; Przyluski 1924). Specialists with more direct knowledge, however, have long recognized that the linguistic affinities of Cham are with the far-flung Austronesian (Malayo-Polynesian) family of languages (e.g. Aymonier and Cabaton 1906). For basic discussion on the broader Chamic grouping of languages (Rhade, Jarai, Chru, Roglai, etc.) see Dyen 1971.

Cham territory during the first century A.D. stretched north of ancient Funan along the Mekhong River from present day Stung Treng (Cambodia) perhaps as far as the mouth of the Mun River above Pakse (Laos). Bounded on the east by the South China Sea, the Cham domain extended, according to Briggs (1951), from the Cam Ranh area up at least to present day Danang. Hickey (1982:map 4) notes Cham vestiges as far south as Bien Hoa (just north of Saigon) and as far north as Hoanh Son and Badon (near the 18th parallel). An island off the coast near Danang is still called in Vietnamese *Cù Lao Chàm*, in which *Cù Lao* probably reflects the original Cham form *palau* (cf. Malay *pulau*) 'island'.

It is further clear that an Austronesian colony (Benedict 1941) has long existed on the island of Hainan (China) just 250 miles off the coast of Vietnam. There seems to be evidence that as early as A.D. 986 Cham refugees in considerable number sought asylum in Hainan from the turmoil then besetting the kingdom of Champa (Maspero 1928:125; Hickey 1982:80). Though the Hainan Cham are Muslims and are in Chinese called *Hui* (cf. Vietnamese *Hồi* 'Islam'), contacts between the island and the mainland plainly predate the period of Islamic influence in

[1] This paper is a group effort. Phu Van Han is a linguist with the Social Sciences Institute in Vietnam and a native speaker of Phan Rang Cham. His interest in Cham tonogenesis prompted the suggestion by Kenneth Gregerson and David Thomas of the Summer Institute of Linguistics in June 1989 that recordings be made to provide an instrumental basis for on-going investigation of the question. Subsequently, Jerold Edmondson directed the instrumental processing of these recordings at the University of Texas at Arlington. Gregerson and Edmondson drafted the final English version of the paper.

the region. Benedict (1984) and Chinese scholars (Ouyang Yueyah Zheng Yiqing 1983 and Ni Dabai 1988) have discussed whether this group is in fact Chamic and what the broader Austronesian or Austro-Thai comparative linguistic implications of the question are.

The Cham in Indochina speak two major dialects: The Western (Cambodian) Cham and the Eastern Cham. The former live along the Mekong in Cambodia as well as in Chau Doc and Tay Ninh in Vietnam. The latter are found in Vietnam near Phan Ri and Phan Rang along the South China Sea.

2. Western Cham Register

In comparison with many of the world's languages, Austronesian languages of Asia and the Pacific are often assumed to be rather unremarkable from a phonological point of view. Cases like the linguo-labials of Vanuatu (Maddieson 1987), of course, rise up to haunt any such easy generalizations. Cham likewise presents some decidedly remarkable phenomena involving prosodic and segmental features.

Western Cham phonology has been described by Friberg and Hor (1977) in terms of contrasting prosodic syndromes that Henderson (1952) in her study of Khmer called "registers." The constellation of features involved are summarized in Fig. 1.

	Original Initials	Voice Quality	Vowel Quality	Pitch
1st Register	*Voiceless	More Tense	Lower	Relatively Higher
2nd Register	*Voiced	Lax, Breathy	Higher	Relatively Lower

Figure 1. Western Cham Register

That is, **First Register** words in Cham are those with original voiceless initial consonants, synchronically a tense to normal phonation quality, a lowered vowel and a relatively higher pitch. **Second Register** words, by contrast, possess originally (but not presently) voiced initials, synchronically laxer, slightly breathy phonation, a higher vowel variant, and a relatively lower pitch. Schematically the situation may be represented as follows:

1st Register = *p- $\acute{v}\,\check{}$
2nd Register = *b- $\underset{..}{\grave{v}}\,\hat{}$

where [́] and [̀] are higher vs. lower pitch, [..] is breathiness vs. plain (unmarked), while [̌] and [̂] indicate relatively lower vs. raised vowel respectively.

It is perhaps worth commenting briefly on each of these register categories:

a) Voicing: The original voicing status of initial consonants is easily attested in the Old Cham writing and in comparative evidence from other Austronesian languages. Both Eastern and Western Cham have lost the old voicing distinction in the modern dialects as seen in the following examples:

PAN **beRey* ,Writ.Cham *brei,* E. Cham *prèy* , W. Cham *pray* : 'give'

PAN **pe/dD/iq,* Writ. Cham *padik,* E. Cham *pediq,* W. Cham *paqdiq*: 'pain'

b) Voice (Phonation) Quality : Friberg (1977:31) describes the nine Second Register vowels of W. Cham as being slightly breathy in contrast to their First Register counterparts. Further, vowel pairs differ along a tense-*normal-lax continuum depending on their height, as shown in Fig. 2.*

First Register	**Second Register**
High Vowels	High Vowels
Mid Vowels	Mid Vowels
Low Vowels	Low Vowels

TENSE------------------------NORMAL--------------------------LAX

Figure 2. Western Cham Registers

That is, in terms of overall perceptual tenseness in pronunciation High Vowels seem to contrast more on the Tense to Normal end of the range, while Mid Vowels appear to differ as Tense vs. Lax and, finally, Low Vowels oppose Normal to Lax.

c) Vowel Quality (Height) : First Register vowels are slightly lower than their Second Register counterparts (Friberg, 1977:31). This is, of course, the pattern familiar in the surrounding Mon-Khmer languages. In Gregerson 1976 it was proposed that this systematic bipartitioning of vowel sets in Mon-Khmer was strikingly similar to African vowel harmony phenomena and perhaps likewise based on tongue-root or pharynx volume differences (see Ladefoged, 1964; Stewart 1967). Friberg explores that possibility for W. Cham, designating First Register vowels [-ATR] and Second Register [+ATR].

d) Pitch: Second Register vowels are described as displaying a lower pitch in Western Cham, and it is noted that Eastern Cham similarly has lowered tone in the context of earlier voiced initials (Friberg, 1977:31).

In terms of the four register exponents above a) Voicing has, of course, been lost and d) Pitch is mentioned only in passing. W. Cham seems therefore to exploit most heavily b) Voice (Phonation) Quality and c) Vowel Quality.

A question of some interest is how an Austronesian language might come by all of the above features. One is, of course, immediately drawn to the obvious observation that hundreds of years of contact with mainland languages with their tendencies towards syllabic simplification on one hand and prosodic complication on the other must have had some effect. But is environment the only contributing factor? Or should one perhaps also look to heredity for at least some underlying predispositions to the developments we now see in Cham? Consider the fact that Javanese 'heavy' vs. 'light' syllables also involve a contrast of breathiness and voicing of initials (Horne 1961). In Madurese Stevens (1968) describes, further, that vowel allophones are lower following voiceless initials than following their voiced counterparts. Thus between these two languages of Indonesia, three of the features of Cham (and Khmer for that matter) are represented under presumably (?) non–contact conditions. As for pitch/tone (even without invoking Benedict's Austro–Thai proposals), several Austronesian languages of Morobe Province in Eastern Papua New Guinea have been long known to have simple two tone systems associated with the expected voicing nature of initial consonants (Capell 1949; Wurm 1954; Hooley 1976:118). Further, Haudricourt (1968) has reported tone in languages of New Caledonia, which among other things involves a correspondence between high tone and aspiration in cognate forms in the area (1971:384). Rivierre 1974 and 1975 further discuss various grammatical and lexical sources for the development of tone in languages of New Caledonia.

3. Eastern Cham Tone

With this background of Western Cham register, we may turn now to the specific question of Eastern Cham tone. Doris Blood (1962) summarizes the major classes of PAN (Malayo–Polynesian) reflexes in Cham. As regards pitch, she says:

> "The voiceless stops of PMP are retained in Cham" while "PMP *b,*d,*D,*/dD/, *j and *g are reflected in Cham as voiceless stops with a component of [low] pitch: *b > p`; *d, *D, /*dD/ > t`; *g > k`; *z > c`."

David Blood (1967) in an overall description again observes the clear role that non–low vs. low pitch plays in Eastern Cham phonology. He gives the following contrastive sets (1967:30):

Low Pitch		Non–Low Pitch	
pà	'to bring'	(tə)pa	'to cross over'
kàh	'direction'	kah	'fish scale'
mətà	'rich'	məta	'eye'
pə̀raq	'north'	pəraq	'silver'
tàləpən	'eight'	taləpat	'to bow'

Figure 3. Eastern Cham Tone Sets

Comparison of these words with Bahasa Indonesia shows an association of voiced initials with Low Pitch forms and voiceless initials with Non–low Pitch, e.g. BI *barat'* west, northwest' and BI *perak* 'silver'.

In personal conversations in June 1989 Phu Van Han, a linguist and native speaker of Phan Rang Cham, raised the question whether certain pitch–related variations might lead in the direction of a prosodic system involving more than two tones. Blood (1967:29) had, for example, also observed that "before final stops and *h* the register of non–low pitch is higher than in syllables ending in other consonants or silence." Blood, however, treated this phonetic variation as a sub-phonemic phenomenon.

The question of how many tones are developing in Cham involves two familiar parameters: the historical nature of the initial and of the final. In his important *Dictionnaire Cam–Vietnamien–Français* Fr. Gérard Moussay proposed that four tones be recognized in the same Phan Rang dialect as spoken by Mr. Han. The fundamental phonological contexts for these four tones may be summarized as in Fig. 4 in terms of initials and finals:

		FINALS	
		Non–glottal Stop (or vowel final)	Glottal Stop
INITIALS	*Vl. C-	CV(C): Level Tone	CVQ: Departing Tone
	*Vd. C-	CV(C): Grave Tone	CVQ: Falling Tone

Figure 4. Moussay's Four Tones

Thus Moussay distinguishes four tonal categories based on the old voicing status of the initials intersecting further with the glottal stop vs. other finals. The voicing contrast indicated in the rows above seems clear, as in Blood (1962), but the question to be dealt with is the extent to which the pitches associated with glottal stop (col. 2) are different from their counterparts without glottal stop (col. 1).

In a similar vein Bui Khanh The (1981:15-16) characterizes Cham as having two (apparently phonemic) tones depending on the initial (bipartition) and three (apparently allophonic) variants for each depending on the final (tripartition). This analysis results from further subdividing the Non–glottal column of Fig. 4 into an original voiced–continuant–final context (-Ø, -y, -w, -m, -n, -ng) vs. a voiceless–obstruent–final context (-p, -t, -k, -h). It is to be noted that the former set have been retained in the modern language, while in the latter the stops have fallen together as glottal stop and *h* has been lost altogether.

Hoang Thi Chau (1987) agrees basically with the four-tone analysis of Moussay as in Fig. 4. Professor Chau observes that while a high pitch in a glottally closed syllable (similar to Vietnamese *ngã* tone) could be viewed as distinct from a high pitch in a syllable closed by a stop other than glottal (comparable to Vietnamese *sắc* tone), it is better analyzed as no more than allophonic variation. Five phonetic elements are thus only four phonemic ones.

In order to examine Cham prosodic phenomena in as objective a fashion as possible and to address the specific question of Cham tone development, Mr. Han made tape recordings of some key sample forms for further processing at the University of Texas at Arlington. We discuss next the results of those analyses.

4. Instrumental Analysis of Phan Rang Cham Prosodies

A series of tape recordings of various monosyllabic utterances were made by Phu Van Han, a native speaker of Eastern (Phan Rang) Cham. These were recorded on a Marantz PMD221 tape recorder using high quality recording tape. The speaker produced examples of words divided according to syllable structure into three classes: (a) open syllables, CV; (b) closed syllables with long vowels, CVVC; and (c) closed syllables with short vowels, CVC. Each of the three syllable types was exemplified in two forms representing original voiceless vs. voiced initial consonants as reflected in the traditional Cham (Devanagari) writing system. These consonants have fallen together in the modern language, but since, as we shall see below, they turn out to correlate with other prosodic effects, the syllable pairs in each class will be distinguished as Set I: p- = original voiceless bilabial stop vs. Set II: P- = original voiced bilabial stop. Thus:

	(a) CV	(b) CVVC	(c) CVC
Set I.	*pa* 'where, at'	*paaq* 'four'	*paq* 'straight'
Set II.	*Pa* 'carry'	*Paaq* 'walk'	*Paq* 'tap (on back)'

4.1 *Voice quality*

From the tape recording made by Phu Van Han it was sensed that the sets of syllables I and II differed in voice–quality settings (as well as in pitch). The auditory impression made by *pa* , *paaq* and *paq* is one of apparent **modal voice**, whereas *Pa* , *Paaq* and *Paq* have a **breathy voice** quality. This latter property is, of course, a familiar concomitant of low tones (e.g. Vietnamese *huyền* tone).

We subjected the pairs of syllables: *pa* vs. *Pa* , *paaq* vs. *Paaq*, and *paq* vs. *Paq* to analysis for voice–quality differences. A recorded syllable was played into the MacADIOS unit and appeared on the CRT of the Macintosh. The Mac Speech Lab I software had been previously extended to enable repeated measurements of the differential between the second and first harmonic ΔF, i.e. (F_2-F_1) of a waveform. The cursors were placed on each side of the waveform on the screen. The Mac Speech Lab I software calculated a narrow–band (28 msec. bandwidth) FFT around the left cursor, recording in a file on the hard disk the values in decibels and the frequency in Hz of all peaks in the FFT curve that exceeded a threshold interactively settable by the user, (a typical value was 40 dB). Having finished the calculation at one sample point, the program moved 5 msec to the right in the waveform and performed the calculations again and recorded the results in a separate file. In this manner, harmonic peaks (in dB and Hz) were recorded at 5 msec intervals across the entire waveform. Once there was a complete set of harmonic peaks at each of the slices, a second program opened each file in turn and extracted the difference between the first two peaks, i.e. ΔF, and placed this new information in a separate file and simultaneously on the clipboard from where it was pasted directly into the graphing program Cricket Graph.[2] Fig. 5 shows a comparison of the ΔF for a representative example of *pa* vs. *Pa* , *paaq* vs. *Paaq*, and *paq* vs. *Paq* .

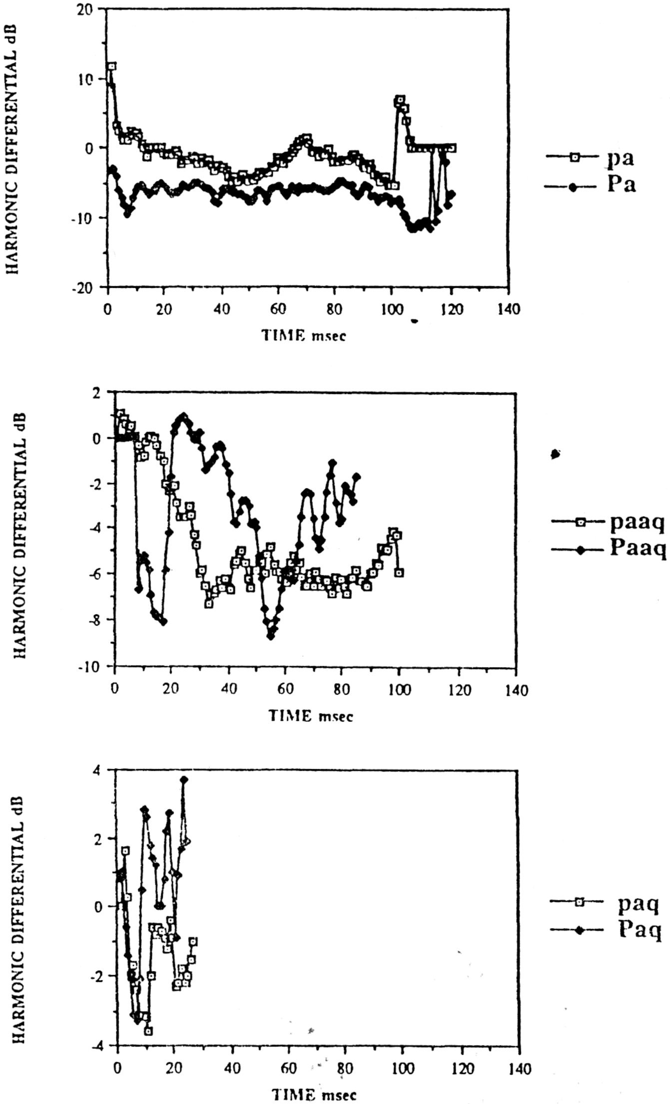

Figure 5. Harmonic Differential

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[2] The ΔF extraction sometimes produces artifactual errors whenever F_1 or F_2 falls below the threshold because the first two peaks above say 40dB might include a higher harmonic. Therefore, the resulting ΔF extraction files were examined and such error points replaced with interpolated values or zero as the situation warranted.

The curves in Fig. 5 show that the two open–syllable types differ in ΔF in a consistent manner. The syllable *pa* has the pattern of modal voice, having positive or at least less negative values of ΔF (F_2-F_1), whereas *Pa* has the pattern of breathy voice showing values for ΔF that are more negative and that in fact do not cross the curve of data points for *pa*. The closed syllable types *paaq* vs. *Paaq*, and *paq* vs. *Paq* appear to be much less consistently different. The auditory impression of these is, however, that *Paaq* and *Paq* are breathy across some part of the syllable's course but that they seem to have some tensing of the vocal folds toward the end of the syllable. This impression arises perhaps from slow glottal closure in anticipation of the following glottal stop.

4.2 *Vowel quality*

Data from Western Cham and Haroi, another Chamic language, suggest (Sec. 2 above) that vowels may be divided into two registers. Register differences in Mon-Khmer of this region also often show concomitant changes of vowel quality (recall Fig. 1). For Eastern Cham Mr. Han perceived that even in isolation vowels could be given separate renditions as Set I vs. Set. II simple V syllables. The question was whether **vowel quality** played an identifiable role in distinguishing the vowels in the two categories. In order to obtain the relevant quantitative data on the vowels of Phan Rang Cham, LPC plots were made with the Canadian Speech Research Environment (CSRE) software running on a 80286 DOS computer with a 40 megabyte harddisk. Results of this analysis (F_2-F_1 vs. F_1) are presented in Fig. 6.

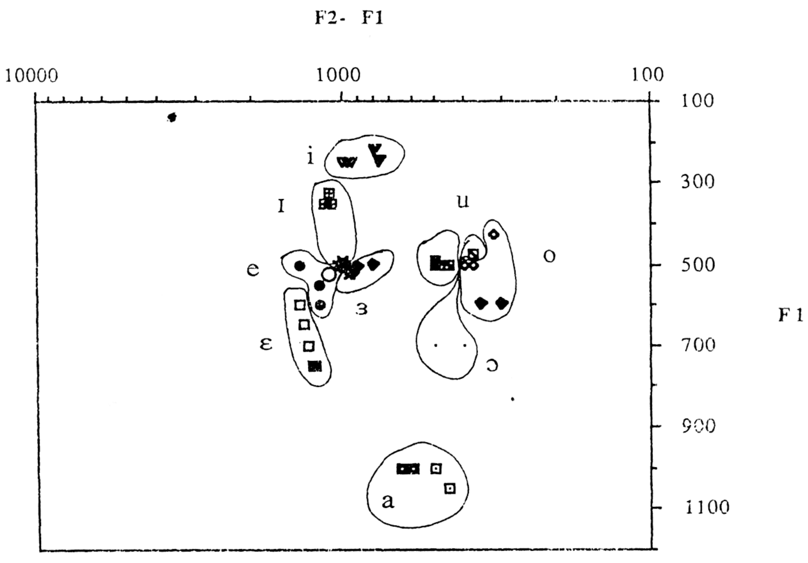

Figure 6. Eastern Cham Vowels

As shown in Fig. 6, the vowel qualities associated with Set I vs. Set II syllables are not in systematic opposition as to vowel height or advancement in the sense of Western Cham "Mon–Khmer–type" register. It is true that Second Register [ɷ] is higher than First Register [ɷ] and that Second Register [a] is higher than First Register [a] as one would predict from Western Cham. On the other hand, [ɛ] and [o] are the reverse. The other vowels do not appear to vary consistently in relation to other Set I vs. Set II register distinctions. The key perceptual discriminators for Eastern Cham syllables seem rather to be **voice quality** (as noted in 4.1) and **pitch** (as in 4.3 below).

4.3 *Pitch*

For the syllables *pa* vs. *Pa*, *paaq* vs.*Paaq*, and *paq* vs. *Paq* there were enough repetitions on the tape that tone composites could be made. The compositing procedure was as follows. First the recordings were played on a Sony TCM-5000 professional quality recorder into a MacADIOS Model 411 (G.W. Instruments, Cambridge, MA) analog–to–digital converter attached to a Macintosh 512 K computer equipped with a Gemini 68020/16 accelerator board (TSI, Inc., Eugene, OR). Three to five repetitions of each of the six types were so entered using a 10 KHz sampling rate and then analyzed with G.W. Instruments, Mac Speech Lab I, $F_ø$ extraction algorithm (42 ms. analysis window). After all the $F_ø$ points of a given syllable were extracted, these data were saved as a file on the Macintosh harddisk. Subsequently another program opened each file and adjusted each data point for time and register according to the mean values of overall pitch height for the 3-5 repetitions and according to the mean length of all the tokens. When this normalization procedure was completed for all the files, the program computed from the adjusted files the mean values of pitch at 10 ms. intervals across all the files to yield a final tonal composite curve, which represented the common features shared by all repetitions of the same syllable. Composites for the six kinds of syllables are given in Fig. 7.

A comparison of the three pairs: *pa* vs. *Pa*, *paaq* vs. *Paaq*, and *paq* vs. *Paq* shows that the Set II (capital P) member is consistently lower in fundamental frequency ($F_ø$) by about 5 semitones. Other data for which we lacked repetitions and for which no composites could be made confirmed the observed pattern of lowered $F_ø$) for the Set II syllables.

Aside from being lower in pitch, Set II syllables also differed from the others in contour. Of the four closed syllable types the two higher types (Set I) demonstrated a nearly level pitch curve, whereas the two lower types (Set II) showed a rising pitch curve. In fact, *Paaq* and *Paq* did not behave identically vis-à-vis *paaq* and *paq* respectively. *Paaq* began about 5 semitones below its counterpart and rose to meet it, becoming nearly identical in pitch with it at the end of the syllable. *Paq,* however, though starting from a point 5 semitones below its counterpart, never reached the level of the higher syllable's $F_ø$. It also seemed to fall off rapidly in pitch as the syllable ended. Also, *paaq* showed a level pitch contour, but *paq* tended to rise slightly but distinctly before settling back to a level position. There were beyond that some global differences in pitch height with CVC being highest, CVVC slightly lower and CV lowest.

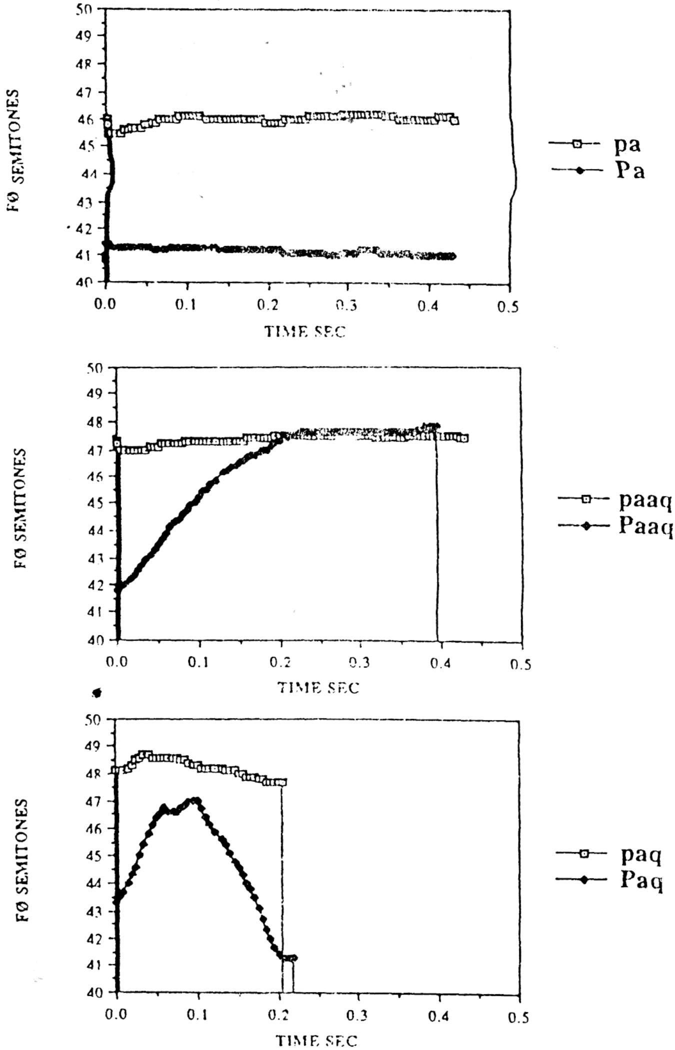

Figure 7. High, Low, and Rising Pitch Patterns

4.4 *Cham pitch prosodies and the nature of tonogenesis*

The pitch plots in Fig. 7 show clear phonetic differences in pitch levels and contours among certain of the six distinctive syllable types. Moreover, the degree of difference between, for example, high level and low level pitch is much greater than that expected from the rise–fall pattern caused by the transglottal pressure changes involved in the consonantal release (which for *p* and *b* would be about 1 semitone or 140 Hz vs. 135 Hz in Painter's 1978 general work on laryngeal mechanisms). The high and low level pitch contours in Cham differ by 4-6 semitones, and these pitch height differences accord with the *voiced–low principle* of tonogenesis (Brown 1985).

As to how many tones Phan Rang Cham has, the answer is not a simple one. If one treats glottal finals (which were formerly 'respectable, regular' consonants) as synchronically no longer part of the external conditioning environment, but rather as part of the internal stuff of a given tone, a longer tone inventory naturally results. Native reaction is another, not always simple, factor. A consideration in this regard has to do with how different a pitch may be physically and continue to be perceived as a *simple variant of another pitch* rather than an element in its own right. All things considered, it seems clear that Cham is perceived by native speakers to have at least two tones (higher vs. lower). It seems too that the collapse of all final stops into glottal has launched Cham into more complex prosodic waters familiar in mainland Asia. The physical difference between the high tone in glottal context and the high tone variants in other contexts does not seem to be nearly as dramatic as that between the low tone plain vs. glottal–final pitches. It is our suggestion, therefore, that tonogenesis has spread only partially to the glottal environment, yielding at present a possible three-tone pattern, in which a Rising Tone is beginning to distinguish itself with glottal finals but much more dramatically in the Low pitch set, as in Fig. 8.

	Non–Glottal Final	Glottal Final
Set I	High Tone	
Set II	Low Tone	Rising Tone

Figure 8. Three Tone Analysis

5. Conclusion

Thus in terms of information load, the prosodic contrast between words of Set I vs. Set II type appears to rank as follows in Eastern Cham:

i) Pitch: higher vs. lower pitch is the most consistent contrast between words. Low rising pitch is rather dramatic for Set II forms preceding glottal.
ii) Phonation: modal vs. breathy phonation partially reinforces prosodic contrast, especially in CV forms.
iii) Vowel Quality: no systematic correlation with pitch or phonation sets occurs.

In terms of the register features of Fig. 1 the facts for Eastern Cham may be summarized as in Fig. 9:

	Original Initials	Voice Quality	Vowel Quality	Pitch
1st Register	*Voiceless (now vl.)	Modal for CV (inconsistent elsewhere)	No systematic contrastive function between registers	Higher
2nd Register	*Voiced (now vl.) No contrast between registers	Breathy for CV (inconsistent elsewhere)		Lower, and Rising

Figure 9. Eastern Cham Registers

Thus the present paper confirms instrumentally what has been observed for E. Cham by others that at least two contrastive tones exist and perhaps an incipient third, but also that breathy vs. modal voice quality plays a partial role.

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