Tone Contours and Tone Clusters in Iau
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Tone contours and tone clusters in Iau

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1. Contour splitters and contour lumpers. Pike (1948) established the most popular typology of tonality in tone languages when he distinguished between *register tone languages* (R-languages), as are found in Africa and the Americas, and *contour tone languages* (C-languages), as are found in East Asia. For decades these two types were regarded as so fundamentally unlike that the appellations *register tone* and *contour tone* became like linguistic blood types; there was little reward in seeking common features in these two. In R-type languages, Highs (H) and Lows (L) were taken as primitives, while contours were regarded as secondary phonological features, and these were often very changeable in larger contexts. Indeed, in general, contouring in R-languages was thought to arise by phonological rules of spreading or buildup of multiple H's and L's on domain-final syllables in polysyllabic domains (XP).[2] In C-languages, traditional and modern phonologists alike generally insisted that contours be taken as primitive, because a lexical contour can occur on potentially any syllable whether domain-final or not and, also, virtually every syllable possesses a lexical tone. In short, the spreading of pitch persuaded Africanists to regard pitch trajectories as *split* into sequences of H's and L's, whereas Asianists were more impressed with the stability of pitch trajectories attached to each syllable and choose to regard the *lumps* as phonological primitives. There are, of course, other differences between the two types—downdrift and floating tones, in R-languages, and tone splitting, tone sandhi, register phenomena and voice quality differences, in C-languages,—but in this paper, we will concentrate on the nature of contours in tone languages and not speak of other important tonal properties.

Recent work by Yip (1989), Bao (1990), Duanmu (1990, 1991, 1992), Hyman (1989) and others has extended the successes of an autosegmental analysis of R-languages to contours in C-languages. Following Sagey (1986), Yip proposes that Asian contour features can be treated like the continuancy feature in affricates—a concatenation of H's and L's with a left and right edge occupying a single organizational slot unified by a tone root tier, where the tonal root tier functions as a register feature.[3] African contours, by contrast, are directly attached to the syllable node. But both types can be analyzed as concatenations of H's and L's

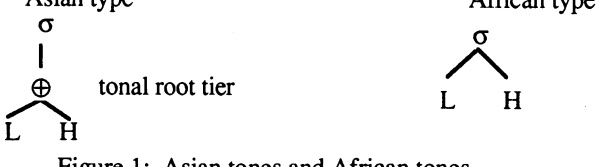

Figure 1: Asian tones and African tones

But once contours are regarded as sequences of features, the question must

arise, how many tones can be associated with a single syllable/mora. At present, some theoreticians feel that there should be a one-to-one relation between the number of moras and tone bearing capacity. For instance, Duanmu (1990:101) concludes that "...in Chinese languages, there is indeed a direct relation between the tone bearing ability of a syllable and its rime length. I will argue that in at least two African languages, Igbo and Tiv, the same relation holds,...I am not aware of clear evidence that a monomoraic syllable indeed carries two or more tones without lengthening."

Against this background, we wish to introduce data from Iau, a Non-Austronesian language of Irian Jaya, Indonesia, in which the tone bearing capacity of a syllable exceeds two tones and which, indeed, demonstrate other rather remarkable tonal properties that show Iau to be neither an R-type language nor a C-type language, but a new type having properties in some respects like a combination of R-types and C-types. Because of the still limited nature of our data we will not propose a formal analysis of the tones of this language at this time.

2. Iau, a Non-Austronesian tone language of Irian Jaya. Iau is one of three varieties of Turu, an SOV Non-Austronesian language of the Lakes Plains District of Irian Jaya, Indonesia spoken by about 400 people living in the villages of Faui and Bakusi along the Van Daalan River. According to a classification by Voorhoeve (1975), Iau belongs to the Tor-Lakes Plains Stock and is an isolate with no immediate relatives. Nevertheless, there are a number of distantly related languages spoken in this same district which also have pitch contrasts. Irian Jaya and Papua New Guinea are not generally regarded as being geographic area with large numbers of tonal languages. However, Iau and some other Lakes Plains languages of this area—Kaure, Obokuitai, Sikaritai, and Doutai—all make use of pitch contrasts in their phonological system, cf. preliminary descriptions in Dommel (1991), Jenison (1991), Martin (1991), and McAllister (1991).[4] Of all these languages, however, Iau is the one with the most developed tonality.

2.1. Iau segmental phonology. Although Iau possesses a complex system of contrastive tones, it has a very parsimonious inventory of segmental sounds and is mostly monosyllabic. Of three thousand words in common use there are only about 100 bisyllabic nouns, Bateman (1991b:38). Iau possesses six consonantal segments //t k b d f s// and eight vowel segments //i ɨ ɪ e a o u ʊ//. Vowel length is not distinctive. The voiced stop segments //b d// are described by Bateman (1991b:29) as being implosive and can also be realized as nasals [m n]. There are no obvious examples of voice quality contrasts in Iau. The following exemplify the consonantal sounds: *te*^{8} 'mosquito', *ko*^{3} 'breadfruit', *bi*^{6} 'grandchild'; *du*^{9} 'wild pig'; *si*^{6} 'woman'; and *be*^{7}*fe*^{7} 'snake'.[5]All consonants occur syllable-initially and word-medially in two syllable words. //f// is realized in a variety of ways depending upon environment and geographic location such as [ɸ h x]. //f// also is found word-finally in a limited number of cases, i.e. *of*^{4} 'arm'. Examples of the vowels are: *bɨ*^{8} 'rain'; *bi*^{8} 'message' *bɪ*^{8} 'door'; *be*^{8} 'fire'; *a*^{5} 'land'; *u*^{8} 'tree'; *ʊ*^{4} 'heart'; and *o*^{7} 'sand'. The most remarkable feature of thevowelsis the fricativization of //ɨ//. The presence of a fricative high vowel appears to be typical characteristic of languages of this area as several nearby languages also have this vowel. There are also diphthongs and triphthongs in Iau, specifically //aɨ ei ai ui oi aɪ ʊɪ ae oe au aʊ aui aʊɪ//. There are copious illustrations of the segments of Iau found in Bateman (1991b:29-35).

2.2. Tone contrasts on monosyllabic nouns. Tones in Iau are used to establish lexical contrasts as well as to mark grammatical contrasts of aspect and perform other grammatical functions. As far as lexical contrasts on monosyllables are concerned, Iau possesses eight distinct pitch trajectories, two level trajectories and six with rising or falling contours, cf. Bateman (1991b).[6]

Tone category	Tone value
Tone 9	44
Tone 8	33
Tone 7	45
Tone 6	23
Tone 5	42
Tone 4	43
Tone 3	32
Tone 2	423

In Figures 2 and 3 below we have provided pitch plots of each of the lexical contrasts on nouns in verification of the auditory impressions of these tones. Tape recordings of the lexical items representative of each of the tone categories were first analyzed. Those examples are as follows: *e*^{9} 'grandparent'; *soe*^{8} 'uncle'; *ty*^{7} 'person'; *a*^{6} 'cross cousin'; *vy*^{5} 'initiated cross cousin'; *a*^{4} 'father'; *y*^{3} 'younger brother'; and *dau*^{2} 'crocodile'.[7] These items were elicited in the frames ___ *si*^{4} 'old ___' and *ba*^{7}*bu*^{9} ___ *by*^{5} 'This is a ___.' Each item was repeated twice in each frame. The cassette tape recordings were played back on a Sony TCM5000 professional quality tape recorder into a CECIL speech analysis box (Jaars International, Inc.), which digitizes, amplifies and filters the signal. The CECIL box was interfaced to a MS-DOS 286 computer, which was running the CECIL speech analysis software, which extracts fundamental frequency (FØ) and intensity information. The fundamental frequency for each token of each tonal contrast was then saved as a separate file, eight tones times four repetitions of each for a total of 32 files. Using some locally developed software, we then performed a compositing operation on the data for each of the tonal categories. This compositing operation time-adjusts (for duration) and register-adjusts (for pitch height) each token to correct for uncharacteristic long, short, high, or low utterances before computing mean values over the four token utterances of each tone contrast. In this fashion the common features of the four repetitions are preserved, while features idiosyncratic to a particular token are discarded. The results of the compositing procedure were then transferred to a Macintosh (Apple Computer, Inc.) and plotted using Microsoft Excel and are shown in the figures below. Grid lines were added to make determination of tone values easier.

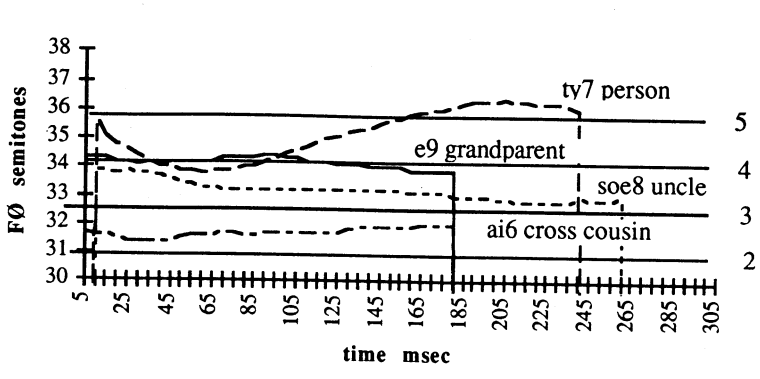

Figure 2: Plot of tone values for tone categories 6-9

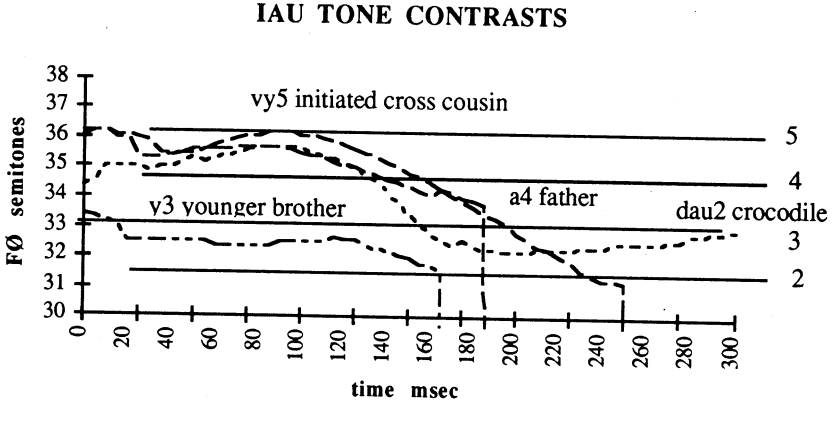

Figure 3: Plot of tone values for tone categories 2-5

Tone 9 in Figure 2 has a level trajectory at the 44 level. We found tone 8 to have a FØ basically at the 33 level with a slight tendency to fall. Tone 7 showed a mid-high to high rising trajectory achieving a level even higher than a 5. Nevertheless, we deemed a 45 to be a reasonable characterization of it. Tone 6 began at the 2 level with an unmistakable rise, although it didn't quite achieve the 3 level. Tone 4 and 5 were falling tones, both beginning somewhat higher than the 4 level. Tone 5 fell to a lower level than tone 4. Pending analysis of larger bodies of data, we will maintain the current transcription of these two tones, 42 for Tone 5 and 43 for Tone 4. Tone 3 demonstrated a level 3 trajectory for the first two-thirds of its course followed by a fall to the 2 level. Therefore, we transcribe as 332 or more simply 32. Tone 2 has the only tone trajectory with a change of direction. Like Tone 5 and Tone 4 it begins slightly higher than level 4 and drops to 2 before rising. The

results of this instrumental analysis confirm strongly the tone values assigned by Bateman (1991b) to the eight tone categories in Iau. The only systematic discrepancy seems to be that the falling tones begin slightly higher than described in Bateman (1991b). Tone 2, whose trajectory changes direction, was also the longest.[8]

2.3. Tone contours versus tone clusters. In addition to the eight lexically determined tones that can occur on noun forms, there are also some nouns that possess tone clusters or combinations of some of the eight basic tone trajectories. Consider, for example, the following contrasting sentences: *da*^{7}*doe*^{9} 'see a dog'; *da*^{8}*doe*^{9} 'see the sky'; *da*$^{8\text{-}4}$*doe*^{9} 'see a mountain'. 'Dog' in Iau is *da*^{7}, 'sky' is *da*^{8}; but 'mountain' *da*$^{8\text{-}4}$ has the same segmental form as these with a pitch trajectory consisting of a tone 8 followed by a tone 4, each lasting about a demisyllable. Instrumental confirmation of this auditory impression is found in Figure 4 in which one token of the three two-syllable sequences are compared in fundamental frequency trajectories.

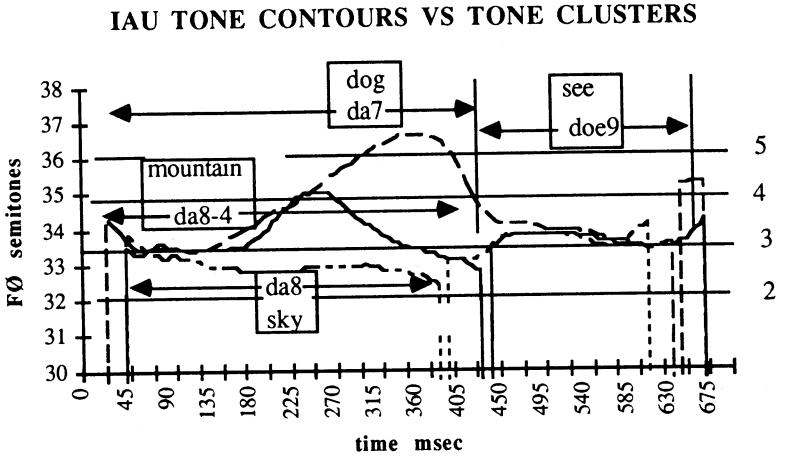

Figure 4. Tone contours vs. tone clusters.

Note first that it is easy to identify the syllable *doe*^{9} 'see', which begins for all three sentences at a point about 400-450 msec into the syllable with pitch height 44, lexical tone 9. By contrast, the direct object NP 'dog', 'sky', and 'mountain' are segmentally identical but distinct in pitch trajectory. The item 'dog' *da*^{7} is indicated by a rising tone starting below level 4 and ascending above level 5 (i.e., 45), whereas the item 'sky' *da*^{8} shows a level pitch at the 3 level (i.e. 33). However, the noun 'mountain' in Iau has a pitch trajectory that is unlike any of the eight contours described in Figure 2 or Figure 3 above. As one can see, 'mountain' is composed of two stretches, a concatenation of two of the eight elementary tone contours in the length of a single syllable. The first half of the syllable (0-175 msec) has a 33 level pitch, whereas the second half—after a transition period—possesses a 43 falling pitch (225-400 msec). This one syllable thus is

composed of a concatenation of two tones from the list of lexical tones, tone 8 followed by tone 4.

Another example of tone clustering on a monosyllabic noun is found in the example *sae*$^{6-4}$ 'machete' in the frame *sae*$^{6-4}$ *doe*^{9} 'see the machete', which should be contrasted with *sae*^{7} *doe*^{9} 'see the brother-in-law' and *sae*^{6} *doe*^{9} 'see the spirit'. The two syllable sequences are plotted in Figure 5.

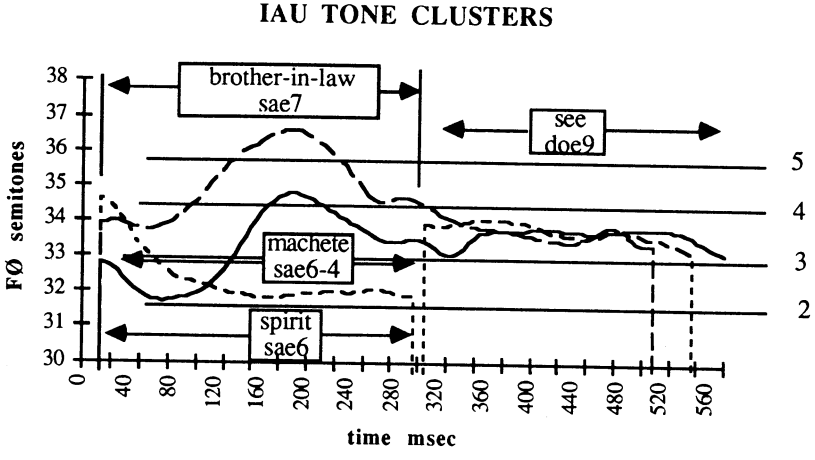

Figure 5: Tone clusters in Iau.

As before, the boundaries of the first syllable are easily recognized. 'Brother-in-law' has a 45 rising course (tone 7); whereas 'spirit, ghost' rises from 2 to 3 (tone 6). However, 'machete', possesses not one of the lexical tones, but rather a concatenation of 6 followed by 4, that is to say a 23 followed by a 43 drop.

2.4. Tone contours to mark verbal aspects. Iau verbs in a context have aspect marking and that aspect marking is signaled by a tone. Bateman (1986:3-6) describes the aspect system of Iau as:

	Punctual	Durative	Incompletive
Totality of Action	Tone 9 (44)	Tone 3 (32)	Tone 7 (45)
Resultative	Tone 6 (23)	Tone 8 (33)	---
Telic	Tone 5 (42)	Tone 2 (423)	Tone 4 (43)

Tone category and tone value in parentheses.[9] As the table makes clear, there is a tone used to signal each of eight verbal aspects.

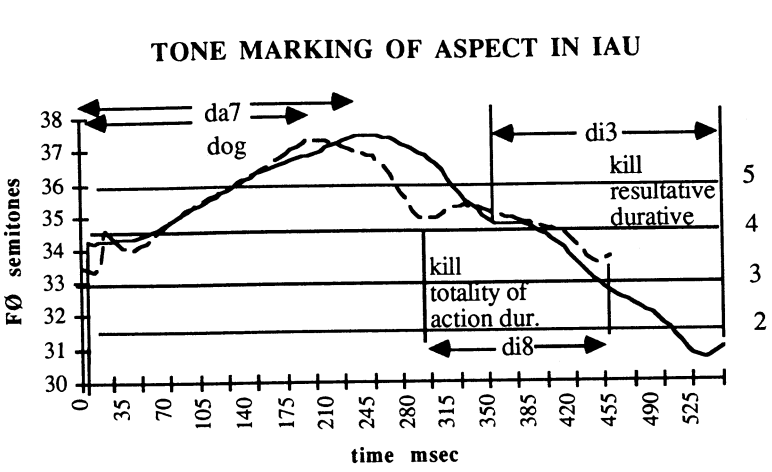

Figure 6: Aspect marking with tones in Iau

In Figure 6 we have indicated those portions of the pitch tracks that correspond to 'dog' *da*^{7}. The latter half of the tow tracks correspond to *di*^{8} 'kill-resultative durative' and *di*^{3} 'kill-totality of action durative' respectively. As is evident, the resultative-durative aspect corresponds to a 32 falling pitch, whereas the totality of action durative corresponds to a 33 level with some fall toward the end.

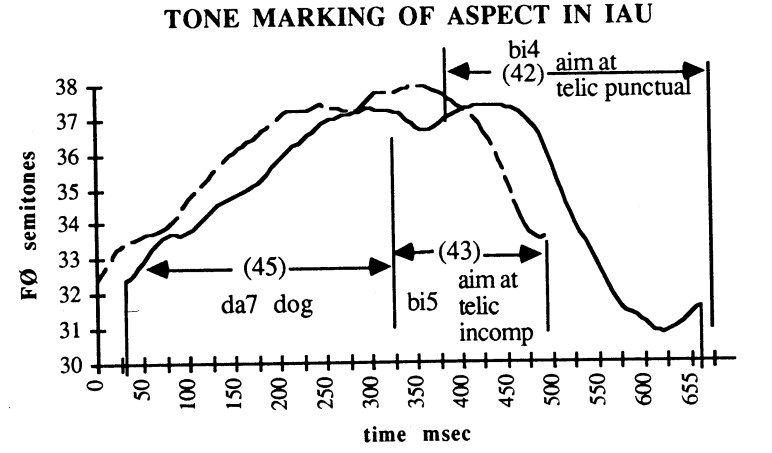

Figure 7: Aspect marking in Iau

2.5. Tone clusters to mark verbal aspects. Not only is pitch used to mark

the system of verbal aspects in Iau, more than one verbal aspect may be combined on a single verb. In Section 2.2 we have noted that there can be *lexical tone clusters* associated with some monosyllabic nouns such as *da*$^{8\text{-}4}$ 'mountain'. Iau also possesses *grammatical tone clusters*, i.e. two aspects can be composed on one monosyllabic verb stem, cf. Bateman (1986:37-42). There are at present eleven possible combinations of aspect marking tones: 9-3, 9-8, 6-3, 6-8, 6-4, 7-3, 7-8, 7-4, 8-5, 8-4 and 4-7. Consider, for example, the aspect tone 8-4 as it contrasts to the aspect tones 3 and 8 in the sentences:

1. a. O^{7} fai^{9} ta^{9} be^{7} baui^{3}. 'We came to the end of the sandbar.'
   sandbar end come to (Process)
   b. O^{7} fai^{9} ta^{9} be^{7} baui^{8}. 'We had come to the end of the sandbar.'
   sandbar end come to (Res-Dur)
   c. O^{7} fai^{9} ta^{9} be^{7} baui$^{8\text{-}4}$. 'We finally reached the end of the sandbar.'
   sandbar end come to (Inter-goal)'

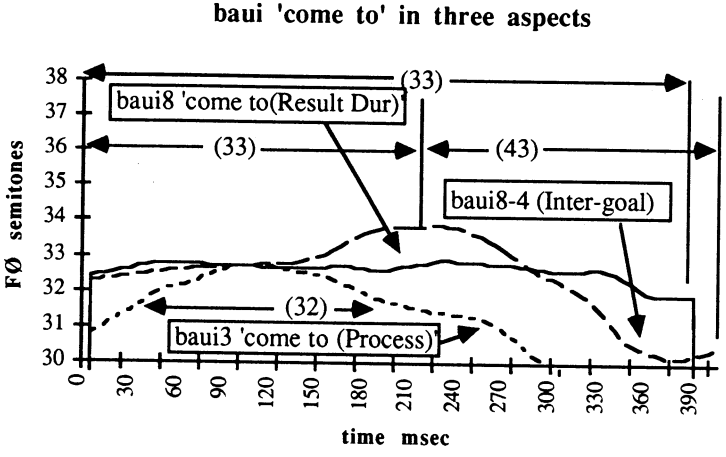

Figure 8: Compound aspects in Iau.

The evidence to date indicates that words evidencing tone clusters in Iau are monosyllabic. Phonetically at least, syllables with clustered tones are not appreciably longer than syllables with simple contours. In fact, the initial or final part of a tone contour in a clustered tone seems to last about one-half as long as a syllable as simple syllables. This timing suggests that only one syllable is involved. Historically, it is not unlikely that some words with clustered tones may have originally come from disyllabic forms. For example, one etymology of the word *da*$^{8\text{-}4}$ 'mountain' may be *da*^{8}*a*^{4} 'sky-father' with the subsequent collapse of the second syllable under maintenance of that syllable's tone contour.

3. Typological implications. The tonal system of Iau represents a new type unlike either the African register system or the Asian contour system It is like

the Asian system in that contours can occur on syllables in isolation, which is one of the hallmarks of a contour tone language, Yip (1989). It is unlike Asian systems in that there is no obvious division into an upper and lower subset of categories.[10] It is African-like, in that there exist complexes that can be assigned to a given syllable. Moreover, some kinds of words, perhaps verbs, may have no lexical tone attached to them. It is just that the combining units appear themselves to be contours with possibly an internal structure. Note, however, that the combinations or tone clusters cannot have the internal organization as exhibited by either R-languages or C-languages, cf. Figure 1. The combinations are not just of atomic H's and L's—though this kind of combination also exists—but that contours are combined.

The capacity of Iau syllables to bear tones is extraordinarily large. It has been suggested that languages such as Iau must possess polymoraic syllables to support such massively laden syllables. It is notable, as Duanmu San (p.c.) has pointed out to us, that syllables in Iau can be as much as 400 msec long. It is also significant that Iau demonstrates two triphthongal syllable rimes //aui au˥//, which would also indicate a complex rime structure.

As far as we know, Iau is the only language that shows clustering of contours, i.e. syllables whose pitch trajectories are composed of two tone contour categories in a single syllable. If there are more such examples, then perhaps we expand our typology to include Register-languages, Contour-languages and Clustering-languages.

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[1]This study of the tonality of the Iau language is a collaborative effort. The first author was made aware of the complexities of Iau by Helen Miehle in 1988. At that time, we decided to undertake an instrumental examination of Iau data. In late 1991 she elicited the help of Janet Bateman and the study began. Tape recordings for the instrumental part of this paper were supplied by Janet Bateman and Helen Miehle. Draft versions of the paper were then circulated among authors via fax. Most of the information about Iau—both raw data and assignment to linguistic categories—comes from Janet Bateman, who has been working on the Iau language for about 10 years. As of 1990, she has been spent about 48 month of village time in Faui working intensively on the Iau language under the auspices of a project conducted by the Universitas Cenderawasih, Irian Jaya, Indonesia and the Summer Institute of Linguistics. Helen Miehle provided original impetus for this paper, some very significant ideas to its central point and crucial bibliographic references. We also wish to thank our native speaker helpers, Das and Sakadia of Furu.

[2]Duanmu (1991b:1) cites the famous case of Margi discussed by Williams (1971/6), which shows the spreading of tones from a verb stem to the toneless causative form.

[3]C-type languages often divide tone categories into upper and lower sets, e.g. mid-to-high rising (35) and low-to-mid rising (13); some may be associated with voice quality differences.

[4]Eunice Pike of SIL (p.c.) has informed us about several additional tonal languages of Irian Jaya. These include: Abun found in the northern Bird's Head, current field work underway by Keith Berry; Irarutu located in the Arguni Bay area, currently being investigated by Takashi Matsumura; Tause of the Western Lakes

Plains, study by Peter Munnings; and Mairasi east and north of Kaimana, Kabupaten Fak Fak, being studied by L. Peckham. Edopi, which seems to be the language most closely related to Iau, is also tonal. LaLani Wood of SIL, Indonesia (p.c.) has also stated that a majority of the 250 languages of Irian Jaya possess some aspects of tonality in their sound systems.

[5]Tone categories are indicated with raised numbers from 2 through 9.

[6]Janet Bateman has used the system of transcribing the phonetic value of tonal heights and contours, whereby 1 is the highest level and 5 is the lowest, cf. Pike (1948:45). Contours are described by means of a two number sequence separated by a dash, e.g. be4-3 'belt', in which 4-3 represents a midlow to mid rising tone. In this paper we have used the more familiar Five-Level System of transcribing tones developed first by Y. R. Chao (1930), in which 55 is a high level tone, 11 a low level tone, and 45 a midhigh to high rising tone. Following Bateman's work we use the digits 2 through 9 to signify phonological tone categories.

[7]We use the orthography used by Bateman, which is identical to that employed by the Dani, a Non-Austronesian language of the area with a large population.

[8]There are also some changes of tone values in context. For example, there is a general tendency toward downdrift toward the ends of domains. Also in a sequence of two syllable with tone 7, the second is somewhat higher, i.e. updrift.

[9]The semantic interpretations of these aspects is the subject of Bateman (1986a). She uses the system developed by Comrie (1976:3), who defines aspect as 'different ways of viewing the internal temporal constituency of a situation.'

[10]We hope to be able to discuss this issue in historical and comparative detail soon. We are currently awaiting more detailed information about neighboring languages. In general, these languages should be very interesting for historical linguists, as these languages must once have had complex morphology that has turned into tonal contrasts.

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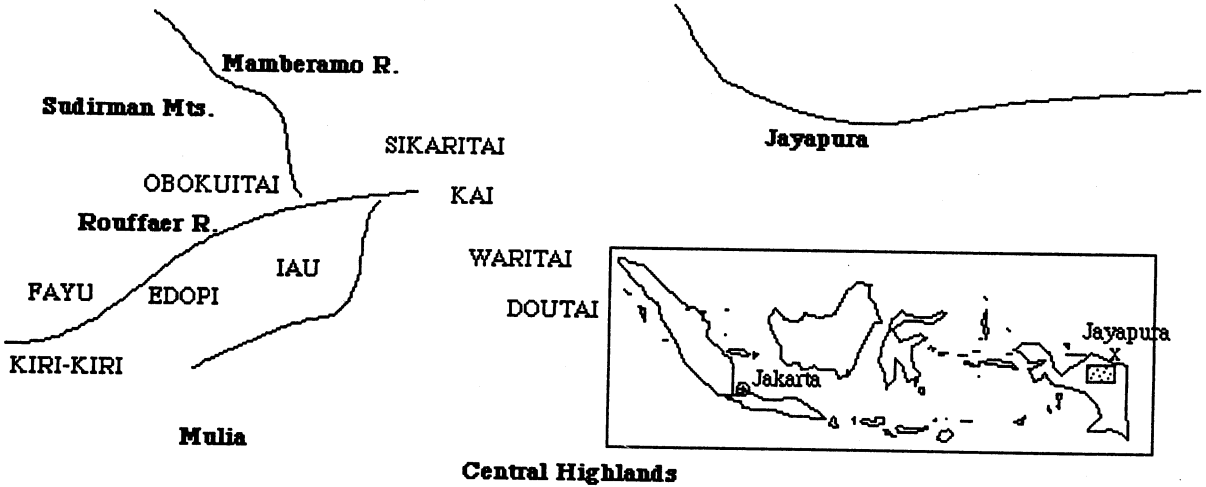

Map: The Lakes Plains District with Geographic features and Government centers in bold; language names in capitals.