

THE NON-UNIQUENESS OF TONE SPLIT: AN EXPLANATORY CHALLENGE

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1. Introduction

In the field of comparative and diachronic Tai, scholars have been struggling over decades to find phonetic motivations for tone splits. The basic hypothesis is that tone splits represent phonologization of pitch perturbations associated with the articulation of initial consonants, such as higher initial pitch after voiceless initial, lower initial pitch after voiced initial. Such phenomena seem to occur universally though their extent may differ, and they are not limited to stops but have been observed even with sonorants (Maddieson 1983, cf. also Thongkum 1993).

The present paper¹ addresses some much-debated but still controversial issues. I shall first argue that tonal flip-flop cannot be explained phonetically as something happening at the time of the initial tone split. Subsequently, I shall add to the already vast literature on tone split by exploiting the potential of functional explanations.² Despite the general embracement of pitch perturbation as the basis of tone split there is no definitive phonetic (articulatory, aerodynamic) explanation of the modified pitches after initial consonants which have been documented instrumentally. In my view it remains equally controversial (in spite of good discussion in House and Svantesson 1996) why and how pitch modifications developed into independent phonetic features with a potential for phonologization.

If pitch perturbation is just an automatic phonetic phenomenon accompanying articulatory states (rather than a more autonomous, truly allotonic phenomenon), one question is why the pitch-perturbating effect of an initial consonant did not simply adjust to changing aerodynamic conditions in case of ongoing consonant mutation. Another question is how such

pitch phenomena could be perceptually dissociated from initial segments and enter the realm of syllable rhymes so as to affect the tone inventory.

A perceptual transformation of consonant-related pitches into syllable tones presupposes high salience of the pitch phenomena in the first place. It seems a plausible hypothesis (in the light of research by Arthur Abramson and others, cf. Abramson and Erickson 1992) that phonetically-based raising or lowering of pitch with different types of consonants has from the outset had a communicative function as a cue to type of initial, much as vowel duration in English cues the difference between "voiced" and "voiceless" finals.

For the understanding of tone split it is an even more significant question to what extent the degree of pitch modification after different types of initials is universal or language-specific. There is solid evidence for the latter; thus it was convincingly demonstrated by Amon Thavisak at the SEALS XI Conference (2001) that there is no universal solution to the pitch-cued subgrouping of aspirated versus unaspirated consonants (and hence to tone split between these). This suggests that the pitch movement associated with an initial consonant type is not just a concomitant feature but can be programmed so as to enhance the discriminatory effect of this cue vis-à-vis other manner-cues, and even to exploit it arbitrarily so as to keep categories distinct in some fashion or other. Such a functional hypothesis is called for in order to explain how pitch movements can follow their own course, survive the coalescence of other cues and take over the full burden of lexical distinctions associated with syllable types.

In tonogenesis "from scratch" it is difficult to see how a speech community would perform the cognitive jump from associating pitch with a syllable onset to associating it with the rhyme. Researchers are increasingly inclined to believe that tonogenesis normally happens via an intermediate phonation type (register) difference such as breathiness versus modal voicing. That has the dual effect of enhancing the pitch contrast and affecting the vowel more, thus facilitating the association of pitch with the rhyme. In tonal languages, however, phonation

type is not such a crucial precursor to tone split since perceptually salient pitch-related phenomena would tend to be integrated with the contours of lexical tones, creating distinct allotones and paving the way for tone split.

2. Tonal "reversal"

The most obvious paradox is the reversal of the expected pitches which one can observe in many dialects of SWT, with a mid or high tone as the reflex of old voiced initials, and even worse: a tone which starts quite low as the reflex of old voiceless initials; a similar scenario has been stated for two Loloish languages by Matisoff, who has spoken of "tonal flip-flop" (Matisoff 1972, pp. 5-9). Clearly that is the very opposite of what one would like to find if one adheres to a strict version of the pitch perturbation hypothesis.

In the early years of the tone-split debate Marvin Brown suggested two explanatory models involving totally different underlying phonetic mechanisms. His more recent model (Brown 1975) rests on the assumption that since the frequency drop accompanying a *voiced initial is followed by a rising pitch there might occur an overshoot giving the impression of a raised rather than a lowered pitch. This is not corroborated by general phonetic theory, and it is quite implausible that it could account for the existence of two opposite tonal trends in SWT dialects.

Brown's former assumption (Brown 1965: 53-54) was that there were alternative ways of producing e.g. aspirated voiceless stops, with quite different pitch-modifying effects. Brown made explicit that this was not based on empirical evidence. It is, however, an ingenious hypothesis, not least considering that he proposed it before it became fashionable in phonetic research to look at both pitch perturbation and "stiff" versus "slack" vocal cords. As the scenario is understood today, however, it is a reasonable point of departure that the consonant mutations conditioning tone split started not with the devoicing of *voiced stops but with the voicing of *voiceless sonorants (there is evidence for this for Tho, cf. Thongkum 1997: 215). That is, tone split may have started in syllables with initial sonorants.

It is hard to see how *voiceless sonorants could ever lower

the pitch for purely physiological reasons. One way out is to speculate that they developed an intermediate, breathy or slack phonation type as a first step toward coalescence with the modally voiced sonorants. There is no corroboration of this, but the really controversial thing about such a physiological explanation of tonal flip-flop is that *it only accounts for a subset of words*. In this case, we are still at a loss explaining the tonal behaviour of words with *aspirated stops: their initials remained voiceless aspirated in all dialects and thus had no reason to depress the pitch in the first place.

I wish to conclude that tonal flip-flop in northern SWT is not a direct reflex of the operation of phonetic factors at the time of tone split. It may be the reflex of an abstract (in the terminology used here: cognitive) generalization across onset types within the "High" consonant category, or it may be an entirely secondary phenomenon, a gradual flip-flop resulting from the later drifting of contour tones within the tonal space. We can just observe that this type of tonal behaviour is a local innovation which spread to neighbouring dialects and languages (cf. its occurrence in Loloish).

3. Consonant categories and tone split

Everybody now agrees that Thai tonology can be described and discussed adequately with reference to a two-dimensional matrix where the X-axis is divided into six columns according to types of syllable-rhymes ("Live", i.e. unchecked syllables with three proto-prosodies: unmarked, *máy èek* and *máy thoo*, and "Dead", i.e. checked syllables with long versus short vowels: *DL*, *DS*), and the Y-axis is divided into three - or more correctly four - rows according to types of initials (cf. Brown 1965, Gedney 1972, etc.). The remarkable fact is that *if two monosyllabic words belong etymologically to the same slot in the matrix they normally stay together forever across the dialects of SWT*. Slots may fall together, but the members of one slot rarely part company. For the most part this association of lexemes (etyma) with particular slots in the tonal matrix even goes back to a stage prior to the split-off of SWT from the rest of the Tai family.

From a comparative Tai perspective the prosodic relevance of this fixed categorization of etyma now seems to be taken as a

non-controversial fact (so that it is migration of words within it that constitutes a challenge), and so it is as long as we are talking about a binary distinction: "High" (including voiceless "Mid") vs. "Low" (including voiced "Mid"). A ternary distinction of initials is, however, phonetically intriguing since it severs this basic distinction and moreover combines incompatible types:

"High": *aspir./voiceless* /*th, *s, *hn, *hl,.../

"Mid": *voiceless* /*p, *t, *c, *k/
 voiced/glott. /*ʔb, *ʔd, *ʔy, *ʔ/

"Low": *modally voiced* /*d, *z, *n, *l,.../

Nonetheless, the prosodic matrix is an extremely robust feature of Tai tonology. This robustness is really what should be given a plausible diachronic explanation. It is much more interesting from the point of view of diachronic linguistic theory than the question how and why the pitch inflections of lexical tones developed the way they did in the different dialects after the Great Tone Split.

Across Tai languages it is noteworthy that if consonants coalesce due to consonant mutation it is *not* so that the coalescences occur between neighbouring consonants in the one-dimensional series *High-*Mid-*Low. Instead, the main generalization is that *Low enters coalescences with all other categories. Most coalescences are with *High (in Southern/Central/Eastern dialects of SWT) or with *Mid-vl (in northern dialects of SWT). Within the dialects considered here it is only in Shan that *Mid-vd stops are involved in (late) coalescences, namely via lenition into oral or nasal sonorants.

In order to trace the course of mutations it is convenient to leave the one-dimensional High-Mid-Low model above and rearrange the four consonant categories - with their reconstructed phonetic values - so that *Low neighbours all the other three. This makes articulatory sense since *Low is supposed to have shared some (in part negatively defined) physiological property or properties with each of the other four categories: it had a non-constricted larynx like *High, a non-glottalized articulation like *Mid-vl, and a vocal fold state (degree of inner and outer tension)

which permits vocal fold vibration, like *Mid-vd. SWT *Mid-vl may, at least in some varieties of SWT, have had low pharyngeal constriction which is still observable in Standard Thai as a devoicing gesture (Rischel and Thavisak 1984); this would explain why it never coalesces with *High, since *High had rather the opposite gesture: wide open passage.

4. Functional/cognitive challenges in explaining tone split.

There are two such challenges which I shall discuss here: (i) Sound changes going in opposite directions contribute to the same tone split, e.g. voicing of voiceless ("High") sonorants and devoicing of voiced ("Low") obstruents join forces in motivating the same tonal bifurcation. (ii) The categorization of lexical items as belonging to one or another tonal category is always a function of the scenario as it was *before* any consonant mutations took place.

Considering the heterogeneous character of the categories "High" : "Mid" : "Low" it is very remarkable that the categorization of initials was nevertheless so extremely robust that it steered the course for the whole tonal reshuffling. This suggests that tonal split may have originated in connection with initial consonants with one particular manner of production and was then generalized to initials with another manner of production although the phonetic conditions were quite different in these other syllables. For example, in the scenario assumed in the discussion of tone "reversal" above it was the coalescence of *hm/*m etc. which caused a phonologization of the pitch difference between syllables with initial "High" and "Low" consonants. The same tonal split, with the very same tonal reflexes, then occurred in syllables with a coalescence of *ph/*b, although the former underwent a change "High" > voiced and the latter a change of the opposite kind: "Low" > voiceless (aspirated). In principle, it is (almost) always so in Tai tonology that an invariant initial consonant conditions the same tone as a mutating consonant if they occupy the same slot in the proto-matrix. This is definitely a non-trivial way for sound change to work.

The assumption of such generalizations across prosodic categories entails that the partition we refer to as High-Mid-Low

had cognitive salience as a framework for the storage and identification of lexical material. It may have remained so in the turmoil of change when conservative and advanced speaking-habits coexisted. That would help to keep track of the identity of lexical items across speaker groups in a transitional flux of consonant mutations and tone splits, and to preserve the easy path between dialects in contact. Even today speakers of different kinds of SWT often adjust quickly to the tone patterns of other dialects and then mostly get the tones of individual items right. This is evidence for an abstract prosodic categorization of lexical items into slots which unambiguously reflect their etymological classification except when a category distinction has been irretrievably lost in a dialect.

Marvin Brown (1965: 109) briefly mentions a fascinating case of tonal restructuring: the dialect of Phanom Phrai which, as Brown puts it, seems to be a case of Ubon "correcting" itself to Roi-et. As I see it, this is strong evidence for the cognitive nature of the great prosodic reshuffling that occurred in SWT. From its location, the dialect in question would be expected to have just one tone in old *máy èek*-syllables but according to Brown it has two distinctive tones in these. Now, his vexing observation is that the expected tone is shared by *High and *Low, whereas the other - an unexpected, higher tone - is found with *Mid only. I totally agree with Brown that such a strange distribution may reflect a partial adjustment to another dialect, in this case Roy-et (Brown 1965: 104), in which *máy èek*-syllables have a low tone with *Low initials whereas a higher tone occurs with *High/*Mid initials. I would like to add, however, that adjustment of a one-tone scenario to a two-tone scenario has nothing to do with the phenomenon of pitch perturbation but has a straightforward cognitive explanation. Speakers of a dialect with all *máy èek*-syllables sharing one tone could not keep track of the distinction between old *High and *Low initials since these had coalesced segmentally, so *Mid was the only category of *Non-Low initials that could be identified segmentally and associated with the borrowed, higher tone. This explains why we encounter in this transitional dialect *an entirely redundant instance of tone split*.

5. The need for tonal distinctions after consonant mutations

The great tone split implied that the ternary or in part binary categorization of syllables in terms of old syllable prosodies was overlaid with binary (or ternary) tonal distinctions in connection with coalescences among syllable initials. The initial coalescences are by and large coalescences which shrink a three-way segmental contrast to a two-way segmental contrast. For the retention of the system of prosodic syllable categories, it is this shrinkage of the pattern of initials that must be compensated for tonally, whereas tonal differences accompanying the *Live-Dead* syllable distinction are strictly speaking a matter of allotonic redundancy.

There would thus be a need for minimally $2 \times 3 = 6$ distinctive tones. Only very marginally, a ternary tonal contrast was motivated by coalescences; this pertains to the category of glides which exhibits a three-way coalescence between High, Mid and Low since both aspirated and glottalized oral glides became plain glides (*hw > w, *ʔy > y). With all other sonorants as well as stops only a binary tonal contrast was called for. Indeed, we find binary splits over most of the area, though ternary splits also occur. This tone-split heterogeneity across dialects was pointed out already by Wulff (1934) and later by Haudricourt (1972) and Fang-Kuei Li (1977).

6. The northern and southern SWT scenarios

There is a deep-rooted difference between the two-way scenario and the three-way scenario of tonal split in the SWT dialects considered here. Interestingly, this agrees well with the division of SWT into northern dialects (the speaker of which may have migrated into Southeast Asia via a western route) and the other dialects (the speakers of which may have come via an eastern route).

For the two-way scenario, the exemplary case is constituted by the northern dialects of SWT, including Shan, Khün, Kammüang and Lü. The point of departure here is that, unlike the coalescence of *High and *Low continuants, the coalescence of stop consonants did not occur between *High and *Low (as in Central Thai) but between *Mid-vl and *Low. Accordingly, a binary tone split occurred so as to separate

syllables with formerly *Low initials from those with which they coalesced segmentally, namely *Mid-vl or all of *Mid. In most syllable types the tonal distinction occurred between *Low and *Non-Low. In the case of *Unmarked Live* syllables in Khün and Kammtang, however, there happened a symmetric tone split between *High/*Mid-vl on the one side and *Mid-vd/*Low on the other side (like in some eastern SWT). In the case of Shan there was no functionally perfect placement of the tone boundary because *Mid-vd stops coalesced with both *Low and *High sonorants (the latter having coalesced with *Low by becoming voiced). In all Shan dialects there occurred a tone split between *Low and *Non-Low in Unmarked Live syllables, and some Shan got an additional tone split between *Mid and *High, i.e. a three-way tone split, which is thus functionally motivated in Shan (in contradistinction to ternary splits in most other types of SWT). The basic tone split separating *Low from both *High and *Mid-vl had a maximal category-preserving (and thus at the same time: etymology-preserving) effect when the whole prosodic roster was threatened by coalescences of *Low with other initials.

The scenario in Southern Thai is totally different. Here we find a rather redundant development of a three-way split, which occurs highly consistently in *Dead Short* syllables and extends more or less across all the old syllable prosodies, though some dialects have binary contrasts instead (especially with *Dead Long* and *máy thoo*-syllables). The Southern Thai tones really look as if they grew out of pitch perturbations (though it remains a challenge for a purely phonetic explanation to account for the fact that sonorants sided with obstruents in their pitch-perturbating effect). There must in any case have happened something to prevent *Low stops from falling together with the plain voiceless *Mid-vl stops when the *Low stops lost voicing.

As has been suggested repeatedly in the literature, it may be that the low-pitch characteristics of *Low stops had been enhanced by a development and generalization of breathy voice quality. If so it remains an open question whether breathiness was extended to all *Low initials prior to consonant mutation, or whether the tonal uniformity with *Low initials is due to a generalization of tone across the category irrespective

of manner of production.

Typologically, tone split in Southern Thai is related to prototypical tonogenesis from pitch perturbations, and it probably originated as a natural phonetic development. As such its phonetic genesis may belong to a different chronological layer than the northern SWT tone splits. The latter may have arisen rather abruptly as a corollary of consonant mutation; the development of the Southern Thai tones, on the other hand, may have happened over time. The phonologization of the Southern tones is, in a sense, still incomplete since *all *Mid initial stops remain segmentally distinct from all other initial stops* so that there is little need for a ternary tonal contrast. There seems to be just one, marginal motivation for such a three-way contrast: the coalescence of the glottalized palatal glide with its non-glottalized counterpart: *ʔy > y.

What is common to the northern and southern scenarios of SWT tone split is that it occurred in a geographical area in which languages have tended strongly to become tonal. Typologically the two scenarios are very different, indeed.

So far I have hardly touched upon the scenario in Central Thai. That is because I think it must be explained as a typological hybrid between the northern and southern SWT prosodic types. It is neither an exemplar of functional optimization of tone splits nor an exemplar of phonetically well-behaved tonogenesis. The pattern of coalescences among initial obstruents in Central Thai is similar to the Southern Thai type. Tonally, however, CT has a binary split in *Unmarked Live* syllables like the northern dialect area but almost always between *High and *Mid/*Low.

It is as if CT started out sharing the incipient stop consonant mutations with Southern Thai but came to be more associated with the northern dialects in the later phase of tone split. A similar line of argumentation makes sense for Lao, but the extremely variegated tonal dialect geography of Lao/Thai Isan suggests interaction with several SWT languages and dialects found in and around this area (such as Phu Thai and Tai Daeng).

Since we have an irreducible number of three old syllable-prosodies, and a basically binary tone split across the SWT dialects, tonal systems of exactly six mutually contrastive tones would be

the theoretical prediction. In fact, we find such systems in many SWT dialects, if we except the Southern dialects with their deviating tonal history.

Ironically, the most influential variety of SWT: Standard Thai has only 5 instead of 6 tones because of an criss-cross coalescence between *máy thoo*-syllables with *High initial and *máy èek*-syllables with *Low initial in Central Thai. Although such a coalescence occurs in a few other Non-Northern Tai languages, at least including Nùng (Central Tai: Luo 1996: 79) and Red Tay (SWT: cf. discussion in Donaldson and Edmondson 1997: 256), it remains exceptional and may somehow reflect tonal interference due to the intermediate position between two quite different tonal systems. As with other coalescences over proto-tones the cognitive pattern is affected; the category distinction in question has no longer any foundation except to the extent that it may be supported by traditional orthography in a highly literate speech community such as that of Central Thai. Unsurprisingly, occasional unetymological spellings occur. One interesting example of this kind is the word for 'fermented tea', /mîang/; it is now spelled with *máy èek* and *Low initial but it must in fact be a reflex of a *máy thoo*-word with *High initial. This is revealed by its tonal behaviour in Kammüang, as far as I understand, and it is confirmed independently by the retention of the voiceless initial in the Mlabri word for 'fermented tea': /hmiäng/, which is obviously a borrowed form predating consonant mutation.

For the dialects outside Southern Thai, and indeed more widely in Tai, there remains a question: why is there a tendency to have the maximum tonal differentiation in *Unmarked Live* syllables? It is mostly in these syllables that we find either two or three different tones when there are two or sometimes only one tone with each of the other old syllable prosodies: *máy èek*, *máy thoo*, *Dead Long*, *Dead Short* (the one-tone situation occurs with *máy èek* in some Northeastern dialects). It is outside the scope of this paper to address that issue, which is a challenge for functional explanations. Part of the answer is probably that *Unmarked Live* was lexically an important syllable type but it is no less relevant that the prosodies of the four marked syllable types (*Live+máy èek*, *Live+máy thoo*, *Dead Long*, *Dead Short*) would interact

phonetically in more complex ways with the tonal force of initials than did the neutral prosody of *Unmarked Live*.

By way of conclusion we find that there is in each dialect typically one type of massive category coalescence, i.e. there is in the first place a functional motivation for a binary split (like in other tonal areas of Southeast Asia), no matter whether the major coalescence happened between *High and *Low or between *Mid-vl and *Low.

Nevertheless, SWT exhibits two quite different scenarios, an essentially binary split found in a northern area, and a ternary split found in a southern area. Although these are reflexes of the same SEA tone-splitting trend they may have developed rather independently of each other since they differ substantially in their exploitation of tone split and also with respect to the phonetic reflexes of tone split.

From a *phonetic* perspective Southern Thai represents a "well-behaved" type: with a three-way tonal split which seems to reflect a gradual development of allotones from cues accompanying the articulation of so-called *High vs. *Mid vs. *Low Consonants. It was a redundancy-laden restructuring, and the only reason why it was possible without leading to an excessive number of contrastive tones in Southern Thai was that it combined with a structural breakdown which happened exactly in the Southern Thai dialects, namely the partial loss of a distinctive *máy èek*-category of syllables.

From a *functional* perspective, on the contrary, the northern SWT dialects stand out by their rational response to the wave of tonogenesis or tone split which at one point swept over the whole area along with consonant mutations.³ Shan, Lü and Khün/Kammüang developed near-optimal solutions to the threatening system break-down in accordance with the segmental and prosodic profile of the particular dialect.

Present-day knowledge of the multifariousness of present-day tonal patterns and pitch shapes across Tai dialects has strongly challenged the formerly influential hypothesis of Brown's (1965) according to which contemporary tone systems reflect various kinds of collapse from an excessive and highly redundant pattern of tone splits shared by all of SWT. Structural considerations of just a

subset of SWT dialects work in the same direction as dialect geography: it now seems overwhelmingly likely that after parting company the main dialect groups of SWT developed tone splits each in its own way, as part of an areal trend. The completion of the whole process of consonant mutation + tone split may have happened quite late in some areas (cf. footnote 2).

Still, Brown's assumption of massive tonal coalescences in the individual dialects may be said to have a point in its favour: across dialects there are indeed vexing asymmetries and irregularities in the prosodic matrix. If compared with *Unmarked Live* syllables, other syllable-types exhibit numerous instances of under-differentiation, i.e. tone-sharing, both along the "vertical" dimension of proto-initials (typically in Lao) and along the "horizontal" dimension of proto-rhyme types (typically in Southern Thai); in some cases such tone-sharing even happens ladder-wise. It remains a diachronic challenge to scrutinize such phenomena and to try to determine how they arose, and to what extent they were functionally motivated. They may in some instances postdate tone split and reflect subsequent coalescences, but they may also date back to the very time of tone split.⁴

Notes

¹ A preliminary version presented at the SEALS Symposium had the somewhat infelicitous title "The cognitive basis of tone split in Thai". Sections which might seem redundant in the context of current debate (e.g. by reiterating points made in Rischel 1986, 1998 vis-à-vis Brown 1965) have been weeded out in favour of a more explicit and consistent line of argumentation. For considerations of space the scope is strictly limited to a few Southwestern Tai (SWT) languages, though there are equally interesting data on a wide range of related languages. - "Central Thai" and "Southern Thai" refer to areal subgroups of SWT; a third which I call "northern" dialects likewise belongs to SWT (as against Li's Northern and Central Tai).

² A structural or functional approach to tone split in Tai is certainly in itself anything but a novelty; it is amply demonstrated in André Haudricourt's classic paper on types

of tonal split (1961, English version 1972).

³ This paper does not address the issue *when* The Great Tone Split occurred in SWT. Thongkum (1997: 205) vividly characterizes it as "a linguistic epidemic that spread through Southeast Asia a thousand years ago". It was probably completed in SWT much later, one piece of evidence in favour of this being the Pali-related sound values of the letters used in spelling SWT words. The dating of Tai loanwords in e.g. Mlabri, which perfectly preserve the proto-initials, is crucial in this context.

⁴ From a phonetic perspective, it is significant that these things happen in syllable types (or rather: rhyme types) with *marked prosodies* (e.g. involving special phonation types) so that there is no trivial prediction of what would be the effect of the syllable initial on the overall pitch contour, e.g. whether initial *W* plus rhyme *X* could plausibly give the same tonal output as initial *Y* plus rhyme *Z*.

References

- Abramson, A. and Donna M. Erickson. 1991 (1992). Tone shifts and voicing shifts in Thai: Phonetic plausibility. Pan-Asiatic Linguistics, Proceed. of the Third Int. Symposium of Language and Linguistics, vol. I, 1-15. Bangkok: Chulalongkorn University.
- Brown, J. Marvin. 1965. From ancient Thai to modern dialects. Social Science Association Press of Thailand, Bangkok. Reprinted 1985 with other papers by Marvin Brown. Bangkok: White Lotus Co.
- Brown, J. Marvin. 1975. The great tone split: Did it work in two opposite ways?. Studies in Tai Linguistics in Honor of William J. Gedney, ed. by Jimmy G. Harris and James R. Chamberlain, 33-48. Bangkok: Central Institute of English Language, Office of State Universities.
- Donaldson, Jean and Jerold A. Edmondson. 1997. A preliminary examination of Tay Tac. Comparative Kadai: The Tai branch, ed. by Jerold A. Edmondson and David B. Solnit, 235-266. Dallas: Summer Institute of Linguistics.
- Gedney, William J. 1972. A checklist for detemining tones in Tai

- dialects. Selected papers on comparative Tai studies by William J. Gedney, ed. by R. J. Bickner et al. = Michigan Papers on South and Southeast Asia 29.191-205. University of Michigan.
- Haudricourt, André G. 1961; 1972. Two-way and three-way splitting of tonal systems in some Far-Eastern languages. *Tai phonetics and phonology*, ed. by Jimmy G. Harris and Richard B. Noss, 58-86. Bangkok: Central Institute of English Language, Mahidol University. (First published in French in 1961 in BSLP 56.163-180).
- House, David and Jan-Olof Svantesson. 1996. Tonal timing and vowel onset characteristics in Thai. *Pan-Asiatic Linguistics, Proceed. of the Fourth Int. Symposium on Languages and Linguistics*, vol. I, 104-113. Bangkok: Institute of Language and Culture for Rural Development, Mahidol University at Salaya.
- Li, Fang-Kuei. 1977. A handbook of comparative Tai. University of Hawaii Press.
- Luo, Yongxian. 1996. Tonal irregularities in Tai revisited. *Mon-Khmer Studies* XXV.69-102.
- Maddieson, I. 1983. The effects on fundamental-frequency of a voicing distinction in sonorants and their implications for a theory of tonogenesis. *Journal of Phonetics* 12.9-15.
- Matisoff, James A. 1972. The Loloish tonal split revisited= Research Monograph No. 7, Center for South and Southeast Asia Studies, University of California at Berkeley.
- Rischel, Jørgen. 1986. Can the great tone split in Thai be phonetically explained?. *Ann. Rep. of the Inst. of Phonetics, University of Copenhagen* 20.79-98.
- Rischel, Jørgen. 1998. Structural and functional aspects of tone split in Thai. *Acta Linguistica Hafniensia* 30.7-37.
- Rischel, Jørgen and Amon Thavisak. 1984. A note on work in progress: secondary articulation in Thai stops. *Ann. Rep. of the Inst. of Phonetics, University of Copenhagen* 18.243-254.
- Thavisak, Amon. 2001. Fo behavior of vowels influenced by aspirated and unaspirated initials in Southeast Asian

languages: implications for tonogenesis theories. Paper for the SEALS XI Conference, Bangkok.

- Thongkum, Theraphan L. 1993. The raising and lowering of pitch caused by a voicing distinction in sonorants (nasals and approximants): an epidemic disease in SEA languages. *Pan-Asiatic Linguistics, Proceed. of the Third Int. Symposium of Language and Linguistics*, vol. III, 1079-1087. Bangkok: Chulalongkorn University.
- Thongkum, Theraphan L. 1997. Proto-voiced plosives and fricatives in Dai Tho. *Comparative Kadai: The Tai Branch*, ed. by Jerold A. Edmondson and David B. Solnit, 191-219. Dallas: Summer Institute of Linguistics.
- Wulff, Kurt. 1934. *Chinesisch und Tai, Sprachvergleichende Untersuchungen*. Det Kgl. Danske Videnskabernes Selskab, Historisk-filologiske Meddelelser XX,3. Copenhagen.