

Bidirectional change in tone: Evidence from Chinese

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1. Introduction

1.1. The theme

This paper concerns the directional nature of tonal changes based on recent changes in several Chinese dialects. The data come from two major sources: (i) examination of a Chinese dialect with speakers across different age groups, and (ii) comparison of the descriptions of tone in several Chinese dialects over the past 150 years or so. Thus, apparent time and real time approaches are combined. After examining concrete historical changes in individual dialects, a synopsis of heretofore not well-known tone changes is given. Specifically, the focus is on the on-going pattern of tone changes over time, as if the tones themselves have impetus to keep moving in certain directions, e.g., either higher or lower. This is referred to here as “directionality of tonal changes”. The causes of some changes are discussed in terms of both internal and external factors.

The locations of 11 dialects examined in this paper are shown in Fig. 1.¹⁾ The Shanghai and Suzhou dialects belong to the Wu group of Chinese, while the others belong to the Northern group, or Mandarin.

1.2. Previous theory on tone change

Aside from theories on tone changes caused by phonetic properties like consonants and vowels, the most systematic and sophisticated theory regarding diachronic tone change in Chinese, or even in Asian-type tone languages in general, seems to be Professor Hisao Hirayama’s “circulation theory of tone value changes”. The summary below is from Hirayama (1984: 33–36)²⁾:

1) The base map came from <http://www.allchinainfo.com/> (accessed 31 December 2014).

2) Hirayama (2005) reviewed his historical studies on tone in Chinese starting from 1972. Hirayama (2011) is his latest reply to the arguments pro and con for his theory so far



Fig. 1 Places examined in this paper

Hirayama's Circulation Theory of Tone Value Changes

1) High level tone, 55³⁾ tends to change into high falling tone, 53, due to relaxing the effort to sustain high pitch at the end of a syllable⁴⁾. 53 can further change into 51 to express a more clear falling tone. As for tones changing in the opposite direction, 51 > 53 can occur, due to relaxing the effort to lower the final low pitch, but 53 > 55 seldom occurs, unless followed by other high pitch tones like 55 or 53. This is because effort is required to increase the pitch at the end of syllable unless other high pitched tones follow. Given a sound correspondence of 55 : 53 (or 51) between adjacent dialects, based on this principle one can infer that the change *55 > 53 (>51) occurred.

2) High falling tone, 51 can change to low level tone, 11, by gradually lower-

3) Following Chao (1930), Chinese linguists generally describe tone values with a 5-point notation, in which 5 is the highest and 1 is the lowest, and the combination of two or more numbers denotes the contour: For example, 33 is mid level, 52 is high falling, 45 is high rising, 113 is low rising with a longer level part in the syllable, and so on.

4) Hirayama (1984: 34, fn. 3) cited Kakita & Hiki (1974: 20)'s observation on tone 1 of standard Chinese pronounced by a Taiwanese speaker: "In order to sustain an extremely constant pitch, raising of larynx is observed towards the final of voicing, compensating for the lowering of pitch caused by a natural lowering of subglottal air pressure.", and says that it is a case of the efforts required to sustain high pitch. The core issues of Kakita & Hiki (1974) can be also seen in Kakita & Hiki (1976).

ing the beginning pitch, i.e. $51 > 31 > 21 > 11$. The opposite change, such as $11 > 31 > 51$ theoretically could occur, but since another high falling tone often opposes 11, hence this kind of change, especially $31 > 51$, is rare.

3) Rising coda may develop when the final pitch of the falling tone is low. That is, pitch might be raised at the end of the syllable, due to relaxing glottal adjustments for low pitch production⁵⁾, resulting in $51 > 512$ or $31 > 312$. Rising coda tends to appear as a redundant feature with a low falling toneme, contrasting with a high falling tone. In addition, a falling tone can change into a rising tone, as $512 > 413$ (312) $> 213 > 13$ (24). Level tones like 22, 33 may occur as 212, 313 during the process of this change.

4) Low level tone, 11 easily changes into mid level tone, 33, and likewise, for mid level tone, 33, into high level tone, 55. $11 > 22 > 33$ is a process which economizes the effort for low pitch production. $33 > 44 > 55$ is preferable in terms of efficiency of communication since high pitch raises the sonority of syllables, although it adds to the effort of high pitch production. Thus, a tone system which lacks a high level tone after the previous high level tone changed into a falling one will tend to drag a mid level tone to fill the vacant slot. Moreover, if a mid level tone raises towards a high level range, then it can push a high level tone to a falling one.

5) Low level tone tends to become a low rising tone, and later a high level tone, by passing through a mid rising tone and/or high rising tone. That is, relaxing the effort to maintain low pitch at the end of the syllable causes $11 > 12 > 13$. In order to avoid low beginning pitch, as well as to increase sonority, changes like $13 > 24 > 35 > 45 > 55$ may occur.

These changing processes can be summarized and schematized as the “circulation of tone value changes”:

5) Hirayama (1984:35, fn.6) cites Kakita & Hiki (1974: 20)’s explanation on tone 4 in standard Chinese: “Larynx gradually raises far prior to the glottal closure at the beginning of voicing, and then it lowers to a great extent towards the end of voicing. In this fashion, it is revealed that an active control which lowers pitch abruptly was involved.”, and says that it reflects a case of laryngeal adjustments of lowering pitch towards the end with a falling tone. He further noticed the mechanism to produce a rising final part with tone 2, 214 in the Beijing dialect, in which the subglottal air pressure piled up by the laryngeal tension for producing low pitch is rejected abruptly at the end of a syllable so that a high pitch emerges. And he says that this phenomenon is also involved with “relaxing of laryngeal adjustments”.

$$\begin{aligned} &11 > 33 > 44 > 55 \\ 55 > 53 > 51 > 31 > 11 > 13 > 35 > 55 \\ &51 > 412 > 213 > 24 > 35 \\ &412 > 313 > 33 \end{aligned}$$

Although this scheme does not include all possible tone changes, it covers the main streams of thought about tone change.

[End of introducing the circulation theory.]

This theory is well constituted systematically as a whole with the power to explain any and all tone correspondences among Chinese dialects (or the same type tone languages). Based on this theory, Prof. Hirayama has conducted many concrete historical studies on Chinese tone.

Yet, this is a deductive hypothesis; empirical examinations are needed. For this reason, this paper tries to induce directionality of tonal changes by comparing recent stages within several dialects across different time stages.

2. Age related-differences: a case study in the Libo dialect of Chinese

The first example is the difference of tones due to the speaker's age in the Chinese dialect of Libo County, Guizhou Province, China. The area is inhabited also by Tai-Kadai tribes, like Sui, Buyi, etc.

Tone categories in Chinese are denoted in terms of historical origins from Middle Chinese dating around the 7th century. There used to be four tones—*ping*, *shang*, *qu*, and *ru*—which are called tones 1, 2, 3, and 4, respectively, in this paper. Some of these tones split due to the voicedness of initial consonants; those derived from voiceless initials are marked as “a” and those that came from voiced initials as “b,” for example, 1a and 1b for *ping* tone. Voiced initials are preserved in the Wu group of Chinese, while they merged with voiceless initials in Mandarin dialects. *Ru* tone (tone 4) had voiceless stop codas -p, -t, and -k, but over the course of time they merged as -ʔ and then disappeared in many Mandarin dialects. In the Libo dialect, the *ru* tone merged with 1b, thus giving the 4 tones, 1a, 1b, 2, and 3. The sound correspondence of tones for Middle Chinese and Libo is schematized in Fig. 2. This scheme is valid for the majority of other Mandarin dialects, except for splits of tone 4 (*ru* tone), for which details aren't described in this paper.

Fig. 3 below shows citation tones of 18 speakers denoted by age, varying

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Middle Chinese	tone 1 (<i>ping</i>)	tone 2 (<i>shang</i>)	tone 3 (<i>qu</i>)	tone 4 (<i>ru</i>)
voiceless initials	1a	2	3	1b
sonorant initials	1b			
voiced initials				

Fig. 2 Sound correspondence of tones for Middle Chinese and Libo

	84	80	71	65	56	47	45	40a	40b	40c	34	31	25	22	16a	16b	8a	8b
1a	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
1b	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
2	45	55,	55	55,	45	45	45	45	45	55,	45	45	45	45	45	45	35	35
		45		45						45								
3	113	113	113	113	113	21,	21,	11,	21,	21	21,	21,	21	21,	21	21	11	11
						213	212	212	113			11,	11,		11,			
											213	213	213					

Fig. 3. Age-related differences of tone values in the Libo dialect

from 8 to 84 years old. These data were obtained by my field investigation in 2003 and first reported in Endo (2004). 130 representative words were selected from a set of 2000 words in order to examine age related differences. Tone values were transcribed based on my auditory impression, as was the custom at that time in Chinese dialect investigations.

Tones 1a and 1b show no variation across speakers; all speakers pronounce them as 33 and 52, respectively. As for tones 2 and 3, two directionalities of tone changes are seen:

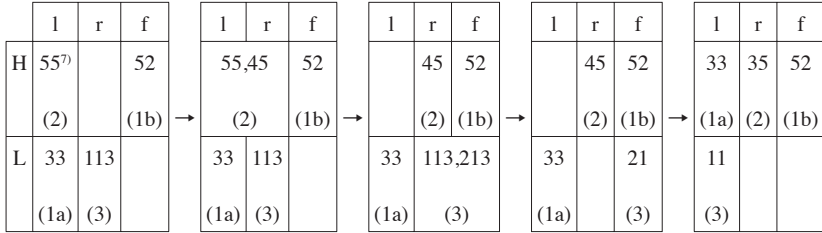
(1) Tone 2 in Libo: 55 > 45 > 35

(2) Tone 3 in Libo: 113 > 213 > 212 > 21 > 11

As seen in Fig. 3, variations of tone shapes are observed for tones 2 and 3, and for some speakers, two or three values are given. The existence of such an intermediate stage is an interesting and important phenomenon accompanying ongoing tonal change.

The tone values of the national standard language, based on the Beijing dia-

lect, are as follows: 1a: 55, 1b: 35, 2: 214, 3: 51. Comparing the Libo dialect with the Beijing dialect shows that the changes of tones 2 and 3 in the Libo dialect are not due to standardization but rather to autonomous changes⁶⁾. The process of changes from the oldest speakers to the youngest speakers is schematized as follows:



Speakers aged 84, 71 (N=2) Speaker aged 80 (N=1) Speaker aged 56 (N=1) Speakers aged 40 to 16 (N=9) Speakers aged 8 (N=2)

Fig. 4. Process of change in the tone systems in the Libo dialect

In Fig. 4, “H” stands for high, “L” for low, “l” for level, “r” for rising, and “f” for falling, respectively. Tone categories are indicated in parentheses below each tone value. Ideally, the tonal systems of all speakers should be treated in the scheme. However, since older forms occasionally appear in younger speakers, skipping the intermediate age, the representative stages were chosen to show a smoother, non-zig-zag changing process. This treatment will be applied below for the other dialects also.

As seen from Figure 4, a tone can change to the next slot if it is vacant. For example, high level 55 changed to high rising 45 in tone 2, and low rising 113 changed via low falling-rising 213 and low falling 21 to low level 11 in tone 3. These are horizontal changes, i.e. changes of contour in the same tone height range. The last change, emerging of a low level tone 11, caused a realignment of the phonological status of tone 1a (33) from low level to high level. This is a

6) As for tone 2, the low part dominates the whole syllable with tone value 214 in Beijing. As a matter of fact, the phonetic variant [214] appears only in citation tone and the stressed syllable at the end of a phrase, otherwise it realizes as low level tone. Hence, the change from 55 to 35 in Libo is difficult to be seen as influenced by the Beijing form.

7) Precisely speaking, speaker 84 pronounced tone 2 as 45. However, 55 seems to be the oldest form for tone 2 in this community. The 65 year old speaker and one of the 40 year old speakers (40c) also have this form as one of the phonetic variants of tone 2.

kind of a vertical change, i.e. a change of height, albeit a relative height change. An example of genuine height change can be observed in Beijing as seen below, from low falling 31 to high falling 51 in tone 3, for example. In theory, a diagonal change involving both changes of contour and height is also possible. However, if the interval between observed time points is long, intermediate stages should exist, unless a new form was adopted directly from another dialect.

Here, each change can be seen as if to avoid the distinction between high-low tones (hereafter referred to the “high-low distinction”) occurring within the same tone shape i.e., level, rising, or falling. As seen in Fig. 4, the high-low distinction of level tones at the oldest stage (as spoken by the older speakers) changed to that of rising tones at the second stage (as spoken by middle aged speakers), and then long low rising became low falling-rising (as spoken by young speakers) in order to be easily distinguished from high rising. But a concave tone, 213 is supposedly difficult to pronounce, because both lowering and rising needs to be done successively; hence this tone changed into low falling (as seen for middle aged speakers) to low level (for young speakers). But notice that the new low tone still contrasts with the mid tone only in terms of pitch height. Thus, a new attempt to resolve the former contradiction triggers another contradiction and so the circle of changes continues, and keeps continuing⁸⁾.

Still, it is also possible to describe such a situation as the intention is to create new high-low distinctions. This is an innate contradiction for a 4 toneme-system, even though this is the dominant system among Chinese dialects. That is to say, there are only three simple tone shapes, i.e. level, rising, and falling. Consequently, a high-low distinction is indispensable to distinguish 4 tones. Moreover, since tone is a small system, a minute change of one of its members sooner or later triggers the readjustment of the whole tone system. Thus, tone changes very rapidly, even during one generation or even more quickly.

8) In Cantonese with 6 tonemes, the high-low distinction is utilized for all level, rising, and falling tones: 1a–52, 1b–21, 2a–24, 2b–23, 3a–33, 3b–22. In such a tone system, the high-low distinction constitutes a correlation (in Praguian concepts); therefore it is rather stable. However, in a 4 toneme system, one contour inevitably constitutes a high-low distinction, but it has only one pair to be utilized, hence it is unstable.

3. Tone change in Beijing over the last 150 years

3.1. Descriptions of tones according to recent past documents

For the past 150 years rather minute descriptions by westerners on tone in Chinese dialects have become available. Also, after Bradley (1915), machine measurements of Chinese tones appeared. Although accuracy of each description or measurement varies, it is possible to trace the process of tone changes in several Chinese dialects using these materials, as well as by looking at present day age-related differences. The most numerous and detailed materials are for the Beijing dialect, the national standard variety. The main resources are listed in Fig. 5 below.

	Meadows 1847	Edkins 1857	Forke 1895	Seidel 1901	Courant 1914	Karlgren 1915	Bradley 1915	Liu 1924	Bröring 1927	Chao 1948	Wang 2009
1a		53,	441								
	55	55		44	33	44	44,55	34	55	55	44
1b	35	35,	45	45	445		35	14		35	24
		353				53			243		
2	13	13	113	114	2233	325	15	114	314	214	203
3	31	31,	331	331	221	41	41,51		41	51	51
		313						4414			

Fig. 5. Historical overview of descriptions of Beijing tones

The descriptions by Meadows (1847) and Edkins (1857) are verbal ones. Meadows (1847: 63) says: “shang ping [i.e. “tone 1a⁹)] commences at a high note, and keeps high and even; hsia ping [tone 1b] commences at a high note, and rises still higher; shang [tone 2] commences at a low note, and rises to a higher one; chŭ [tone 3] commences at a low note, and sinks still lower.” These descriptions were converted into a 5-scale notation in Fig. 5. The same applies to the following descriptions.

Edkins (1857: 17) quoted the description by Meadows (1847) first, and then said: “The following account differs but little from this. It has been drawn up

9) Here, all comments in [] are done by the quoter, the same hereafter.

from the pronunciation of a native of Ta-hing, one of the two districts included in the city of Peking.

I [tone 1a] Upper quick falling tone, or upper even tone.

II [tone 2] Lower quick rising tone.

III [tone 3] Lower quick falling tone, or lower slow falling circumflex tone.

IV [tone 4] Distributed among the other four.

V [tone 1b] Upper quick rising tone, or upper quick falling circumflex tone.”

Edkins (1857: 18) continues: “In the pronunciation at Peking, I [tone 1a] is sometimes u.e. [upper even 55]; III [tone 3] is also heard as l.s.f.c. [low slow falling circumflex 313]; and V [tone 1b] is also u.q.f.c. [upper quick falling circumflex 353]. It is not uncommon in Chinese dialects for two intonations to be appropriated to one tone-class.” According to Edkins (1857:16): “In Peking, words of the third tone-class [tone 3] receive usually the intonation lower-slow-falling-circumflex when alone, but when quickly spoken and when they stand last in a collocation of two words, they are heard in the lower-quick-falling intonation.” This means there are two conditional forms for tone 3: it is low concave in citation form, while otherwise it is low falling.

Edkins (1862: 97) says: “Words in first tone class, 上平 shang p’ing [tone 1a], take the upper quick falling inflection. But this becomes the upper even monotone, in combination with another word following.” This means tone 1a is pronounced as high falling in citation form and at the end of a phrase, while it is pronounced as high level in non-final position.

Edkins (1862: 97) continues: “Words in the fifth class, 下平 hia p’ing [tone 1b], take the upper quick rising inflection, or occasionally the upper quick rising circumflex, which is a double inflection, first rising and then falling.” Edkins (1862: 97) says: “When two words of this class are placed together, the last is pitched high, and becomes the upper quick falling inflection.” This lesser-known sandhi rule is remarkable.

The descriptions by Forke (1895), Seidel (1901), Courant (1914), and Chao (1948) are given in staff notation. Bradley (1915), Liu (1924), Bröring (1927), and Wang (2009) are the results of machine measurement. Both types are converted into 5-scale notation in this paper.

Karlgren (1915: 258–9) discusses the tone value of 1b: “Ce ton [tone 1b] est plus court que le chang p’ing [tone 1a], et l’impression générale est celle d’un

ton descendant. M. Courant indique pour le hia p'ing [tone 1b] une élévation rapide. En réalité les deux variétés de ce ton existent à Pékin, et il doit être difficile de décider quelle est celle qu'il faut regarder comme la plus «généine». Il est possible que le ton montant soit un peu plus commun.” Karlgren (1918: 24) says: “As to its form the **hia p'ing shêng** [tone 1b] appears in Peking in two varieties. Many speakers produce it as a high-keyed falling tone (as opposed to the **k'ü shêng** [tone 3] as a low-keyed falling one)... Others, perhaps the majority, produce it as a rapidly rising tone... This surprising double nature of a tone inside the very city of Peking has been already observed by Edkins. [He cited Edkins (1857:17) in the following.]”

Wang (2009) measured tones of each generation in Beijing. She discovered that tone 1a has an age-related difference: Speakers over 50 years old pronounced it as high level, otherwise it is high slightly falling, and the younger the speaker, the steeper the fall.

3.2. The process of change in Beijing tones

Based on the descriptions above, the changing of each tone in real time can be traced as follows.

First, in the system of Edkins, tone 1a was either high falling or high level; tone 3 was low falling. In the 20th century, the high falling shape of tone 1a disappeared. The change was as follows:

(3) Tone 1a in Beijing: 53 > 55.

Second, the high rising form of tone 1b has been kept intact. Another form of tone 1b, the high falling circumflex described by Edkins and Karlgren, disappeared in the 20th century.

Third, in early documents, tone 2 was low rising with a longer low part; but it is clear that the machine measurement by Bradley (1915) was simple rising. After Karlgren (1915) and Chao (1948), it became low falling-rising. Consequently, in the 20th century, tone 2 added a falling phase at the beginning, and changed from low rising to low falling-rising as follows:

(4) Tone 2 in Beijing: 13 > 14 > 214

Fourth, tone 3 was low falling according to earlier studies, such as Edkins (1857), Meadows (1847), Forke (1895), Seidel (1901), and Courant (1914), but gradually has become high falling

(5) Tone 3 in Beijing: 31 > 41 > 51

The low falling-rising form, which occurs in citation form as well as in phrase final position, as seen in Edkins (1857) and Liu (1924), disappeared; thus, the sandhi rule concerning tone 3 also disappeared. As a result, high falling became a vacant slot. After this change, low falling could become high falling, like tone 3. Two small differences are also noteworthy: Tone 1a was slightly rising according to Karlgren (1915) and Liu (1924). But according to Wang (2009), it was slightly falling.

Fig. 6 shows the process of change in the tone system in Beijing.

	Meadows 1847			→	Edkins 1857			→	Forke 1895			→	Karlgren 1915			→	Chao 1948		
	r	l	f		r	l	f		r	l	f		r	l	f		r	l	f
H	35	55		→	35	55,53		→	45		441	→		44	53	→	35	55	51
	(1b)	(1a)			(1b)	(1a)			(1b)		(1a)			(1a)	(1b)		(1b)	(1a)	(3)
L	13		31		13	313,31			113		331		325		41		214		
	(2)		(3)		(2)	(3)			(2)		(3)		(2)		(3)		(2)		

Fig. 6 Process of the tone change in Beijing

The system of Meadows (1847) is similar to the present Beijing system, but tone 3 is low falling, and tone 2 is low rising, not low falling-rising. The system of Edkins (1857) seems more complicated, because he described citation forms as well as sandhi forms. In the system of Forke (1895), tone 1a has a high falling form only, not a high level form as seen in other descriptions. In the system of Karlgren (1915), tone 1b has a high falling form only, not a high rising form as seen in other descriptions. Moreover, the beginning of tone 3 became higher, and it ultimately became a high falling 51, according to Chao (1948).

4. Examples in other dialects

4.1. Nanjing dialect

As for tone 1a of Liu (1995), the older generation has contour 31, and the younger generation, the contour 41. From the above comparison, the directionalities of the changes are as follows:

(6) Tone 1a in Nanjing: 31 > 41

	Edkins 1857	Kühnert 1894, 1898	Chao 1932	Jiangsu 1960	Fei and Li 1993	Liu 1995
1a	11 or 31	gleichmässig [level]	322	31	31	31>41
1b	35	gleichmässig [level]	113	13	13	23
2	13	steigend [rising]	22	22	212	112
3	42	fallend [falling]	43	44	44	44
4	short	abschneidend [abrupt]	4	5	5	5

Fig. 7 Historical overview of descriptions of Nanjing tones

(7) Tone 1b in Nanjing: 35 > 13 > 23

(8) Tone 2 in Nanjing: 13 > 22 > 212 > 112

(9) Tone 3 in Nanjing: 42 > 43 > 44

Fig. 8 shows the process of the changes in the tone system in Nanjing:

	Edkins 1857				Chao 1932				Jiangsu 1960				Fei and Li 1993				Liu 1995		
	r	l	f		r	l	f		r	l	f		r	l	f		r	l	f
H	35		42	→			43	→		44		→		44		→	23	44	41
	(1b)		(3)				(3)			(3)				(3)			(1b)	(3)	(1a)
L	13	11/31			113	22	322		13	22	31		13	212	31		112		
	(2)	(1a)			(1b)	(2)	(1a)		(1b)	(2)	(1a)		(1b)	(2)	(1a)		(2)		

Fig. 8 Process of the changes of the tone system in Nanjing

Tone 4 occurs only in syllables with a glottal stop, and occurs in complementary distribution with other tones. Consequently, it is not included in Fig 8.

As seen in Fig. 8, there are two rising and falling tones respectively in the system of Edkins (1857). Tone 1a has two variants, low level and low falling, also frequently observed in present-day dialects. At the stage of Chao (1932), the low level form of tone 1a disappeared, and tone 2 changed from 13 to 22, which filled the vacant slot of the low level tone. Tone 1b changed from 35 to 13 and occupied the original place of tone 2. In this system, two falling tones have a high-low tone distinction, where the distance between 43 and 322 is very small. At the stage of Jiangsu (1960), tone 3 changed from 43 to 44, restoring the previous problem of similar tone shapes. However, a new high-low distinc-

tion between the two level tones 44 and 22 emerged. At the stage of Fei and Li (1993), tone 2 changed from 22 to 212, distinguishing it easily from a high level tone. A circumflex tone has a shape difficult to pronounce; since it is important to avoid tones that vary in height alone, a part of the tone would become convex or concave, even at a high cost of production. By the time of Liu (1995)'s study, 212 changed to 112, and the original low rising 13 changed to the higher 23. 23 is not a high tone in terms of absolute height, but it is relatively higher than 112, so it constitutes a new high-low distinction.

4.2. Yantai dialect

Fig. 9 is a comparison of various descriptions for the Yantai dialect:

	Edkins 1862	Qian 1959	Shandong 1963	Qian 1982	Chen 1988	Jiang and Xu 1990	Ding 1995	Sun 2007
1a	13	21	21	31	31	51	31, level	51
1b	31	42	55,445	55,445	55/31	53	35, 53, 55	55
2	35	214,45	214	214	214	213	214	214
3	53	42	55,445	55,445	55	53	35, 53	55

Fig. 9 Historical overview of the descriptions of the Yantai tone

Qian (1959) describes tone 2 as 214, and explains that there is another free variation, form 45. As for tone 3, Shandong (1963) and Qian (1982) described it as 55, and noted that it is accompanied by a slight rise at the end as 445, but the beginning is higher than tone 2.

In the system of Chen (1988), tone 1b has two forms, which are identical to tone 1a and tone 3, respectively. Jiang and Xu (1990) measured 2 speakers aged 19 and 21, Sun (2007) measured 4 speakers around 50 years old, and Ding (1995) measured several young speakers around 20 years old. Regarding tone 1a, 6 speakers pronounced it as 31, and 14 speakers as a level tone; tone 1b was pronounced as 53 or 54 by 7 speakers, as a rising tone by 11 speakers, and as a short level tone by 2 speakers.

The distinction between tone 1b and 3 of the mid-19th century merged into a mid-falling tone.

As for tone 2, Qian (1959) described two forms: high rising which emerged after Edkins (1862) and low falling-rising which dominated afterward. These two forms are too distant from each other to be caused by an internal change. Consequently, the low falling-rising form probably was adopted from the national standard Beijing or the Liaodong peninsula.

Fig. 9 shows the following directionalities of changes in tone:

(10) Tone 1a in Yantai: 13 > 21 > 31 > 51

(11) Tone 1b in Yantai: 31 > 42 > 55, 445 > 53

(12) Tone 2 in Yantai: 35 > 45, 214

(13) Tone 3 in Yantai: 53 > 42 > 55, 445 > 53

Fig. 10 below shows the process of change in the tone system in Yantai:

	Edkins 1862			→	Qian 1959			→	Shandong 1963			→	Sun 2007			→	Jiang and Xu 1990		
	r	l	f		r	l	f		r	l	f		r	l	f		r	l	f
H	35		53	→			42	→	445, 55			→		55	51	→			51
	(2)		(3)		45,	(1b,3)			(1b,3)					(1b,3)	(1a)				(1a)
L	13		31		214		21		214		21		214				213		53
	(1a)		(1b)		(2)		(1a)		(2)		(1a)		(2)				(2)		(1b,3)

Fig. 10 Process of change in the tone system in Yantai

In the course of 100 years from Edkins (1862) to Qian (1959), rather big rearrangements occurred in the tonal system of Yantai. The trigger seems to be the above-mentioned adoption of the national standard form 214 for tone 2. According to Cao (2008: 19), this dipping form of tone 2 is wide spread across the sea surrounding Yantai: northern Hebei including Tianjin, and Dalian in the Liaodong peninsula, with which Yantai has close relationships through sea routes. After Shandong (1963), only the dipping form survived as a result of competition with the older form, high rising 35 and 45.

With the intrusion of the 214 form for tone 2, a similar form 13 for tone 1a in Edkins (1862) changed into 21 in Qian (1959) and Shandong (1963). The intermediate process from 21 to 13 is unknown due to lack of material.

Concerning the number of tones in this tonal system, the biggest change is

the merger of tone 1b with 31 and tone 3 with 53. This process is a loss of the high-low distinction in falling tones which then changed into a mid falling tone 42. This type of change occurs easily. The change of tone 1a from 13 to 21 pushed the original 31 of tone 1, which may be due to a push chain¹⁰.

This new coalesced tone of 1b and 3 further changed from 42 in Qian (1959) to 445, and 55 in Shandong (1963). Since there is only a 4 year difference between the two, and also, since the same author probably wrote both, this reported change is surprising. Maybe it's due to a change in the perception of the representative norm in Yantai, rather than an actual change in the tone *per se*.

After a half century, tone 1a changed from 21 to 51 as seen in Jiang and Xu (1990) and Sun (2007). Since the age of speakers in Sun (2007) is older than in Jiang and Xu (1990), Sun (2007) is listed in Fig. 10. Thus, the direction of the change with tone 1b/3 between these two descriptions should be 55 > 53.

4.3. Dalian dialect

Another interesting example of tone merger is observed in the Dalian dialect, on the opposite side of Yantai, across the gulf of Bohai. Gao (2007: 52–54) measured age-related differences in tones in the present Dalian dialect, which are denoted as old, middle, and young in Fig. 11.

	Song 1963	Gao 2007 old	Gao 2007 middle	Gao 2007 young
1a	312	31 (male), 41 (female)	=tone 3	=tone 3
1b	34	24	24	24
2	213	213	212	212
3	53	52 (male), 51 (female)	51	51

Fig. 11 Historical overview of the descriptions of the Dalian tone

From this comparison, the following directionalities of tone changes are shown:

10) “Push chain” and “drag chain” are notions of linguistic change caused by the paradigmatic pressure. See Martinet (1952).

(14) Tone 1a in Dalian: 312 > 31 (old male) > 41 (old female) > 51 (middle and young)

(15) Tone 1b in Dalian: 34 > 24

(16) Tone 2 in Dalian: 213 > 212

(17) Tone 3 in Dalian: 53 > 52 (old male) > 51 (old female, middle, and young)

Fig. 12 below is the process of changes in the tone system in Dalian:

Song 1963				Gao 2007 old male				Gao 2007 old female				Gao 2007 middle, young			
	r	dipping	f		r	dipping	f		r	dipping	f		r	dipping	f
H	34	312	53	→	24		52	→	24		51	→	24		51
	(1b)	(1a)	(3)		(1b)		(3)		(1b)		(3)		(1b)		(3,1a)
L		213				213	31			212	41			212	
		(2)				(2)	(1a)			(2)	(1a)			(2)	

Fig. 12 Process of change in the tone system in Dalian

In this process, two aspects are noteworthy: (1) older females played an important role in the merger of the former high and low falling tones, and (2) they pronounced tones 1a and 3 similarly in terms of shape, although they are more difficult to distinguish—thus, the younger generation has lost this distinction. On the other hand, there is another structural background for this change: the distinction between tone 2 with 213 and tone 1a with 312 must have been quite difficult to maintain, and the merger of tone 1a with tone 3 solves the problem.

4.4. Shanghai dialect

In Shanghai, the fourth tone, *ru*, still prevails as a glottal stop coda. In the columns for tones 4a and 4b in Fig. 13, an underlined numeral (e.g., 12) signifies a short pronunciation.

Xu and Tang (1988:56) describe 3 varieties in Shanghai, which are denoted by 19881, 19882, 19883, respectively. The first variety is the older generation from surrounding counties; the second is the older generation from the old Shanghai town in the Southern district; and the third is the middle and young

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	Edkins 1853	Pott 1917	Chao 1928	Jiangsu 1960	Xu and Tang 1988 ¹	Xu and Tang 1988 ²	Xu and Tang 1988 ³	Ping 2001
1a	53	53	41	53	53	53	53	51
1b	11	?	=3b	=3b	31	=3b	=3b	=3b
2a	55	?	32	=3a	44	44	=3a	=3a
2b	113	313	=3b	=3b	=3b	=3b	=3b	=3b
3a	35	35	23	34	34, 35	34	34	445
3b	13	13	13	14	23	23	23	113
4a	5	5	4	5	5	5	5	4
4b	1	1	23	2	<u>12</u>	<u>12</u>	<u>12</u>	<u>23</u>

Fig. 13 Historical overview of the descriptions on the Shanghai tone

generation, who are dominant.

The following directionalities of tone changes are shown:

(18) Tone 1a in Shanghai: 53 > 51

(19) Tone 1b in Shanghai: 11 > 13

(20) Tone 2a in Shanghai: 55 > 32 > 34

(21) Tone 2b in Shanghai: 113 > 13

(22) Tone 3a in Shanghai: 35 > 23 > 34 > 445

Fig. 14 below is the process of tone change in the tone system in Shanghai¹¹⁾:

Edkins 1853				Chao 1928				Xu and Tang 1988 ²				Ping 2001			
	r	l	f		r	l	f		r	l	f		r	l	f
H	35	55	53	→	23		41	→	34	44	53	→	445		51
	(3a)	(2a)	(1a)		(3a)		(1a)		(3a)	(2a)	(1a)		(2a,3a)		(1a)
L	13	11			13		32		23				113		
	(3b)	(1b)			(1b,2b,3b)		(2a)		(1b,2b,3b)				(1b,2b,3b)		
	113														
	(2b)														

Fig. 14 Process of change in the tone system in Shanghai

11) Tones 4a and 4b are omitted in this scheme, since they occur only in checked syllables with

The merger among 1b, 2b, and 3b occurred before Chao (1928); however, Pott (1917) reports that 2b is still independent. That means lower tones are independent tones vis-à-vis paired higher tones, in spite of complimentary distribution. Otherwise, it is impossible that only lower tones coalesce with each other while paired higher tones remain untouched.

The value of tone 2a was high level in Edkins (1853) as well as in Xu and Tang (1988)², while it is mid falling 32 in Chao (1928), and it coalesced with 3a, 445 in Ping (2001)

It is noteworthy that the number of tones diminished from 8 to 5 within 100 years in Shanghai. From a phonemic point of view, there are only two tonemes—1a including 4a vs. all others—because of complementary distribution. That is to say, in the system denoted by Xu and Tang 19883 and Ping 2001 above, tone 4a and tone 4b occur only with final glottal stops, and thus can be interpreted as identical to tone 1a and tone 3b, respectively. On the other hand, tone 3b occurs only with initial voiced consonants; since tone 3a doesn't occur with initial voiced consonants, 3b can be interpreted as a variant of tone 3a. This results in phonological distinctions between tone 1a and tone 3a only.

The population of Shanghai has increased the most rapidly in the history of mankind; because of this, mixtures of dialects occurred widely, which has triggered a drastic simplification of the whole phonological system including tone, within a very short time interval.

4.5. Suzhou dialect

The tone system of the Suzhou dialect is similar to that of Shanghai, since they both belong to the same subgroup, Wu.

From Fig. 15, the following directionalities of ongoing tone changes are shown:

- (23) Tone 1a in Suzhou: 53 > 44
- (24) Tone 2a in Suzhou: 55 > 51
- (25) Tone 2b in Suzhou: 31 > 231
- (26) Tone 3a in Suzhou: 35 > 512 > 422

glottal stop and constitute a complementary distribution with the other tones. The situation is the same for Suzhou below.

	Edkins 1853	Chao 1928	Liao 1958	Jiangsu 1960	Ye 1993	Wang 1996	Sun 2001
1a	53	44	44	44	55	44	44
1b	13	14	24	13	13	223	224
2a	55	41	51	52	51	51	51
2b	31	441	31	31	31	231	231
3a	35	512	412	412	513	523	422
3b	113	=2b	=2b	=2b	=2b	=2b	=2b
4a	5	4	5	5	5	<u>43</u>	<u>53</u>
4b	1	23	2	2	3	<u>23</u>	<u>23</u>

Fig. 15 Historical overview of the descriptions of the Suzhou tone

(27) Tone 3b in Suzhou: $113 > 13$

Fig. 16 below is the process of changes in the tone system in Suzhou:

	Edkins 1853			→	Chao 1932				→	Jiangsu 1960				→	Sun 2001			
	r	l	f		r	l	f			r	l	f			r	l	f	
H	35	55	53			44	41	512			44	52	412			44	51	422
	(3a)	(2a)	(1a)			(1a)	(2a)	(3a)			(1a)	(2a)	(3a)			(1a)	(2a)	(3a)
L	13, 113		31		14		441			13		31			224		231	
	(1b), (3b)		(2b)		(1b)		(2b,3b)			(1b)		(2b,3b)			(1b)		(2b,3b)	

Fig. 16 Process of changes in the tone system in Suzhou

There are a series of realignments from Edkins (1853) to Chao (1932): (1) $53 > 44$ in tone 1a and $55 > 41$ in tone 2a constitute a so-called “flip-flop” change. Unfortunately, the metamorphosis process of this change can’t be traced, due to insufficient intermediate materials. (2) $35 > 512$ in tone 3a also shows a large change for which the formation process is unknown. (3) $113 > 441$ in tone 2b is also a mysterious change, because a long low rising tone 113 didn’t merge with a similar shaped low rising tone 13, but rather coalesced with 441.

The tone systems of Chao (1932) and Jiangsu (1960) are essentially identical. There are two changes from Jiangsu (1960) to Sun (2001): (1) $31 > 231$ in tone 2b/3b, which occurred between Ye (1993) and Wang (1996), and after that, (2)

412 > 422, which occurred between Wang (1996) and Sun (2001). There are 3 falling tones in Suzhou after Chao (1932), although voicedness of initial consonants differentiates 2a, 3a and 2b/3b. Dipping or peaking shapes can help to distinguish them.

4.6. Kaifeng dialect

Kaifeng was the former capital of the Song Dynasty. The dialect belongs to Mandarin.

	Edkins 1853	Chao 1922	Zhou, Wu and Wang 1957	Kaifeng 1960	Henan 1995	Liu 1997
1a	55	24	24	24	24	24
1b	35	52	41	41	53	41
2	13	45	55	55	55	55
3	31	213	31	31	31	312

Fig. 17 Historical overview of the descriptions of Kaifeng tones

From Fig. 17, the following directionalities are uncovered:

(28) Tone 1a in Kaifeng: 55 > 24

(29) Tone 1b in Kaifeng: 35 > 52 > 41

(30) Tone 2 in Kaifeng: 13 > 45 > 55

(31) Tone 3 in Kaifeng: 31 > 213 > 31 > 312

Fig. 18 below is the process of changes in the tone system in Kaifeng:

	Edkins 1853				Chao 1922				Kaifeng 1960				Liu 1997		
	r	l	f		r	l	f		r	l	f		r	l	f
H	35	55		→	45		52	→		55	41	→		55	41
	(1b)	(1a)			(2)		(1b)			(2)	(1b)			(2)	(1b)
L	13		31		24	213			24		31		24		312
	(2)		(3)		(1a)	(3)			(1a)		(3)		(1a)		(3)

Fig. 18 Process of tone changes in the tone system in Kaifeng

There are a series of changes from Edkins (1853) to Chao (1922). After Chao (1922), the distance between each change isn't so large. Tone 2 changed from

45 to 55, and the former high-low distinction of rising tone disappeared. However, in the system of Kaifeng (1960), tone 3 changed from 213 to 31, tone 1b changed from 52 to 41, and thus, the distance between these two tones became too close. At the stage of Liu (1997), tone 3 changed into 312 in order to make it easier to distinguish from tone 1b, 41.

It is quite striking that the tone systems of Kaifeng and Beijing described by Edkins (1853) were almost identical, but after 150 years, their shapes have changed completely.

4.7. Jinan dialect

The Jinan dialect also belongs to Mandarin.

The descriptions for tones 1a as 41 and 1b as 31 by Forke (1895) are hard to understand. Yet, Edkins (1857) also gives two values 53 and 131 for tone 1b. What these tones were remains a question. Bousack (1957), although published later than Giet (1950), was a missionary to China, and his descriptions probably reflect a stage before 1949. For this reason, Bousack (1957) is placed prior to Giet (1950).

	Edkins 1857	Forke 1895	Bousack 1957	Giet 1950	Shandong 1960	Jiang and Xu 1990	Qian 2001
1a	55	41 34	24	213	213	223	213
1b	53, 131	45 31	42	42	42	543	42
2	35	45	25	55	55	444	55
3	13	31	41	31	31	321	31

Fig. 19 Historical overview of the descriptions of the Jinan tones

From Fig. 19, the following directionalities of tone change are shown:

(32) Tone 1a in Jinan: $55 > 41 > 24 > 213$

(33) Tone 1b in Jinan: $53 > 45 > 42, 131 > 31$ ¹²⁾

- 12) A reviewer pointed out that it is not highly plausible that this tone changed from high falling to high rising to mid falling to circumflex to low falling in the course of 150 years. Different transcribing strategies must have been involved.

(34) Tone 2 in Jinan: 35 > 45 > 55

(35) Tone 3 in Jinan: 13 > 31

Fig. 20 below is the process of change in the tone system in Jinan:

	Edkins 1857				Forke 1895				Bousack 1957				Giet 1950 to Qian 2001		
	r	l	f		r	l	f		r	l	f		r	l	f
H	35	55		→	45		41	→	25		42	→		55	42
	(2)	(1a)	53,		(1b,2)		(1a)		(2)		(1b)			(2)	(1b)
L	13		131		34		31		24		41		213		31
	(3)		(3)		(1a)		(1b,3)		(1a)		(3)		(1a)		(3)

Fig. 20 Process of change in the tone system in Jinan

4.8. Tianjin and Chengdu dialects

The tone systems of Tianjin and Chengdu dialects according to Edkins (1853:11, 1857:18) remain intact basically:

	Tianjin		Chengdu	
	Edkins 1853, 1857	Yang, Guo, and Shi 1999	Edkins 1853, 1857	Beijing Daxue 1995
1a	11	21	55 or 35	44
1b	35	45	11 or 31	31
2	13	13	53	53
3	53	53	13	13

Fig. 21 Comparisons of tone systems of Tianjin and Chengdu over 150 years

As for tone 1a of Tianjin, Wang (2009:64) found that speakers over 20 years old pronounce it as 31, while those under 20 years old, as 41. Compared with Fig. 21, the following directionality of tonal changes is shown:

(36) Tone 1a in Tianjin: 11 > 21 > 31 > 41

In Chengdu, tone 4 was pronounced as 331 by the older generation; today, it has merged with tone 1b, 31 (Yuan 1960):

(37) Tone 4 in Chengdu: 331 > 31

5. Conclusion

The 37 types of tone changes extracted from the 11 Chinese dialects described above are summarized in Fig. 22.

There are 4 lines composed of boxes in which tone shapes are indicated. The first line includes 5 tone shapes with high pitch denoted by “H”, second, with mid “M”, third and fourth, with low “L”. Contours are denoted by small letters, “r” stands for rising, “l” for level, “f” for falling, “fr” for falling-rising, and “rf” for rising-falling. The direction of change is denoted by an arrow between two tone shapes, and each dialect is denoted by place names with the tone category above or under the arrows.

As seen from Fig. 22, the arrows for the most part link adjacent tone shapes bidirectionally. There are 3 examples which seem to skip intermediate shapes: (1) Hfr > Hf in Suzhou 3a, (2) Hr > Hf in Kaifeng 1b and Jinan 1b, (3) Lr > Lf in Yantai 1a and Jinan 3. As for case (1), the actual distance that exists between high falling-rising and high falling is similar to that of other adjacent tone shapes, although this may not be clear from the way the diagram is drawn. Whether a direct change can occur between falling tone and rising tone is an important issue which requires to be considered further. It is also possible that there did exist missing intermediate stages, but they aren’t traced because of lack of materials. Another possibility is a borrowing from other dialects as seen in Yantai tone 2.

An additional exception is the change from low falling to high falling which is observed in 6 places, while the reverse direction is never seen. One reason for this directionality may be that the change from 31 to 51 of tone 3 in Beijing as seen in 3.1 is an autonomous process with no structural basis. Aside from the Beijing case, the changes in the other dialects can be interpreted as a result of standardization, even though the tone category is not necessarily the same as in Beijing. That is, the younger generation replaced the original tone shape of low falling in their dialects with the high falling shape of tone 3 in Beijing--since practically all members of the younger generation throughout the nation are good speakers of the standard language.

Returning to Professor Hirayama’s circulation theory, almost all tone value changes which he postulated can be attested to empirically, and tone values indeed can be shown to circulate over the course of time. However, according to

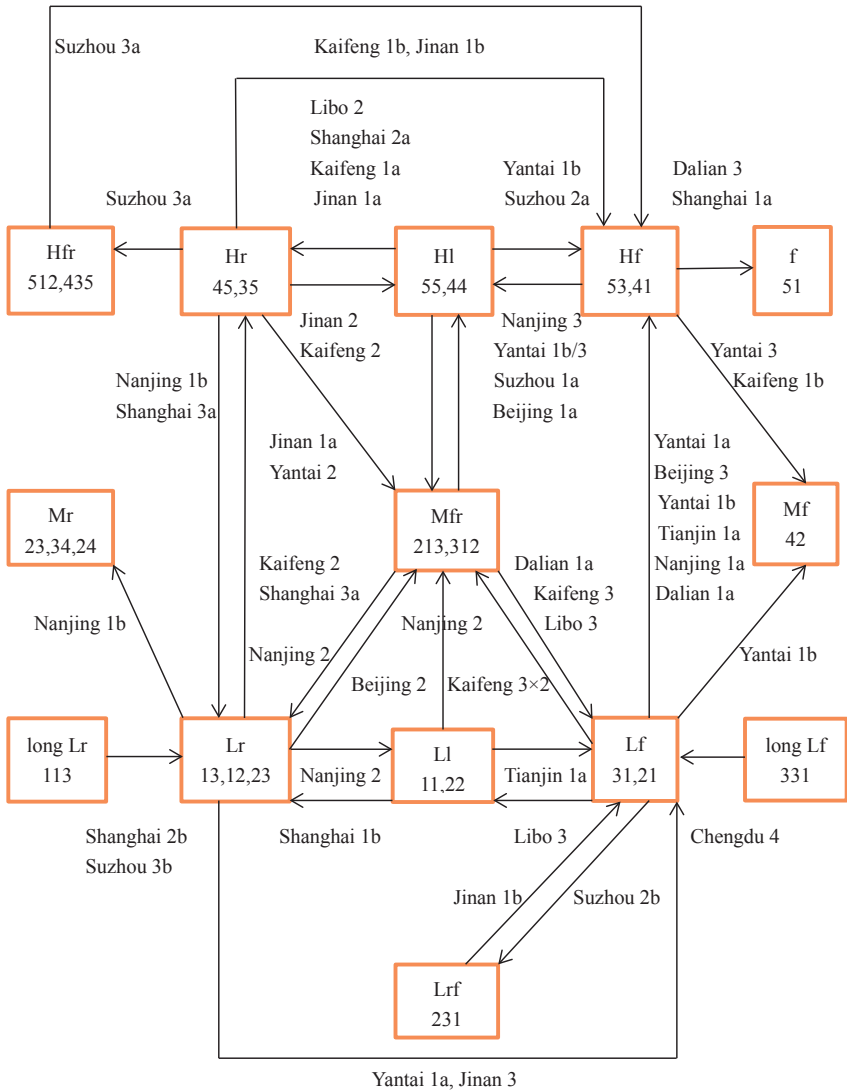


Fig. 22 Diagram of directionalities of tone change among Chinese dialects

the tonal changes revealed in this paper, the process of tonal change isn't unidirectional, but rather bidirectional. For example, high level 55 can change into high falling 53, yet changes in the reverse direction are equally observed.

The importance of this discovery is that it means that it is impossible to reconstruct proto forms based on sound correspondences. In the case of consonants and vowels, certain phonetic directionalities of sound change are already established, such as [ki] easily changes into [tei] or [ai] into [ɛ:] while the reverse isn't necessarily true, etc. etc. In such cases, it is possible to safely reconstruct proto forms [**ki*] or [**ai*] based on sound correspondences of [ki] : [tei] or [ai] : [ɛ:] among dialects or languages¹³). However, in the case of tone, since both 55 > 53 and 53 > 55 are equally possible to occur, it is impossible to decide which form is older, if only the sound correspondence 55 : 53 is available.

In this regard, Karlgren was prudent to *not* reconstruct tone values for Ancient Chinese (the present term is “Middle Chinese”), while he reconstructed its consonants and vowels some 100 years ago. His core points of reconstruction are still valid until now. It is clear that tone can change rapidly during decades, and as a result, a tone system can change into a totally different one in a short term. It is too dangerous to reconstruct tone values over 1000 years ago, only using materials from dozens of modern dialects. This insight concerning tone change is helpful to avoid a short circuit in comparing modern dialects. Endo (2015) examined tone in some 250 dialects of Tai-Kadai languages, but bearing this difficulty in mind did not attempt to reconstruct proto forms for the long distant past.

Concerning future prospects, it is desirable to increase the number of dialects and languages. Examples from Asian-type tone languages, especially, can be treated within almost the same framework. For example, Kondo (2015) gives a good example of recent tone changes in northern Vietnamese, like 31 > 44 in tone 6, 35 > 25 in tone 35, and a new variety 31 emerged in addition to the original 313 in tone 3. Hopefully, a vast number of such examples of tonal changes will be gathered along the lines of Kümmel (2007) in which examples of consonantal changes in Semitic, Indo-European, and Uralic language fami-

13) More systematically, Hock (1991: 83) even gives a chain concerning the weakening hierarchy of consonants.

lies are treated exhaustively. Such studies would contribute to the understanding of diachronic changes in Asian-type tone languages, and as well as to other types throughout the world.

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