Musical Problems in the Zhouli

Véronique Alexandre Journeau

Orient-Archäologie
Band 33

Ricardo Eichmann / Fang Jianjun /
Lars-Christian Koch (Hrsg.)
Studien zur
Musikarchäologie IX

Musical Problems in the 周礼 *Zhouli*

Véronique Alexandre Journeau

Zusammenfassung

Das 周禮 *Zhouli (,Riten der Zhou') ist ein bedeutendes Buch der chinesischen Antike, dessen Datierung sowie einige Inhalte noch nicht zufriedenstellend geklärt werden konnten. Aufbauend auf frühere Artikel der Autorin über alte Musik in China, ist das Ziel des hier vorgelegten Beitrags, die Entwicklung der Musik in China zwischen dem Beginn und dem Ende des ersten Jahrtausends v. Chr. besser zu verstehen. Hierfür setzt sie sich u. a. mit unklaren Statements aus dem* Zhouli *auseinander:* „凡乐，圜钟为宫，黄钟为角，太蔟为征，姑洗为羽" *(„Normalerweise in der Musik: yuanzhong für gong [tonisch], huangzhong [do] für jue [die dritte], taicu [re] für zheng [das fünfte], guxian [mi] für yu [das sechste]").*

1 Introduction

The 周禮 *Zhouli* is an important text of Chinese antiquity of uncertain date in which some obscure contents have not yet been fully elucidated, just as with ancient Greek statements, for example on musical problems stated in the Προβλήματα (*Problemata physica*) of the 3rd century BCE (attributed to Aristotle). Some specialized commentators think the text may contain copy errors and propose that certain terms be modified to make it understandable. As an example of this on the Chinese side, there is a recent paper related to musical statements in the 周禮 *Zhouli* by Chen Kexiu, who studied one of the obscure sentences.[1] In order to solve these puzzles, one must rediscover the theory of music of the time, both forgotten (since the original meaning of the texts is unclear) and enriched (by archaeological discoveries and resulting new analyses, as is the case with the Zenghou Yi chime bells). The musical content of the 周禮 *Zhouli* differs from other reference texts, such as historical and canonical texts like the 禮記 *Liji* (Book of Rites) dated around the end of the Warring States period (transmitted by the disciples); the 史記 *Shiji* (Historical Records) written by Sima Qian (145–86 BCE); nar-

rative and cosmogonic versions like the 呂氏春秋 *Lüshi chunqiu* (Springs and Autumns of Lü Buwei, ca. 291–235 BCE), top adviser in the Kingdom of Qin (the conquering state which unified China); and the 淮南子 *Huainanzi* (Book of the Prince of Huainan) of Prince Liu An (179–122 BCE), who was surrounded by a court of specialists in all disciplines. If the 周禮 *Zhouli* originated in the beginning of the 1st millennium BCE,[2] the musical theory of that time may differ from that passed on by the later works mentioned above, which were written or re-edited in the last three centuries before our era. This would explain the difficulties in interpreting the musical statements that we will now discuss. As a result of previous articles,[3] we submit a new hypothesis for the interpretation of an obscure statement following the one studied

---

[1] Chen 2011, 12: "In the Chapter of the Great Officer of Music, 'play do, sing ré' is a text remained enigmatic in the course of time from the past until nowadays" (《周礼·春官》 "大司乐" 所载 '奏黄仲，歌大吕'等，是一则令古今学人疑惑難解的文献。). In this paper, we will use {*do, ré, mi, fa, sol, la, si*} as Chinese musicians do more or less nowadays when writing Western notation, and *huangzhong = do* as a basis for the examples (it is the same reasoning with *huangzhong = fa*).

[2] This hypothesis supported by Édouard Biot 1851 with the help of an argument which is not musical, and I agree with him, but here I supply some musical arguments. My reasoning in this paper underlines the importance of the third, *jue*, and the absence of the *shang* note, both elements coherent with two Chinese papers concerning the Chu Gong Ni bells that are dated from the late Western Zhou (11th–8th centuries BCE). These were written by Guo Shuqun and Kong Weifeng (Guo – Kong 2012, 231) about the first case "Samples from the Neolithic period are scare, but from the intervals that they constituted there is a tendency towards the third interval in its triads and tetrachords," and Shao Xiaojie (Shao 2012, 84) about the second case when she says "From the note-row in every octave, the range of this set of bells across four octaves and the note-row is sparse. There were only *gong, jue, zhi, yu* in small group 1, small group 2 and small group 3 of the register, but no *shang* in the note-row of this whole set of bells." Moreover, we will see that my reasoning leads to an explanation of the structure of the Zenghou Yi chime bells (dated 5th century BCE) presented in Joseph Chen's paper (Chen Cheng-Yih 1996).

[3] Cf. Journeau 2008b and Journeau 2011 (Topoi International Workshop 2011).

by Chen Kexiu: "Ordinarily in music, *yuanzhong* for *gong*, *huangzhong* for *jue*, *taicu* for *zheng*, *guxian* for *yu*" ("凡樂，圜鍾為宮，黃鍾為角，太蔟為徵，姑洗為羽"), the enigmatic part being: *do* for the third (*jue*), *ré* for the fifth (*zheng*). Our aim is to clarify this statement, especially for what it may reveal about the evolution of music from the beginning to the end of the 1st millennium BCE, based on the discovery of a change in the name of the notes. In most of the mentioned texts,[4] the naming of pentatonic notes is as follows: 宮 *gong* (tonic), 商 *shang* (second), 角 *jue* (third), 徵 *zhi* (fifth), 羽 *yu* (sixth). And yet in the 周禮 *Zhouli*, not only 徵 *zhi* is written in an old manner (徵),[5] but above all 商 *shang* seems to be missing – at least in certain ceremonies – when the four other notes are mentioned. Consequently, the succession of intervals is: {two tones, one and a half tone, a whole tone}, because either there is no splitting of the ditone (third) into two tones at this time, or there is a deliberate omission of the name of the former dynasty by the one which defeated and succeeded it. Moreover, in a passage referring to the twelve pitch-pipes (律呂 *lülü* system), 圜鍾 *yuanzhong*,[6] which is neither defined nor used at later stages, is present, as are 函鍾 *hanzhong* and 小呂 *xiaolü*, instead of other names in use at later stages.

2 Musical Context in the *Zhouli*

The obscure statements still being debated today are in the part of the 周禮 *Zhouli* where the role of the great music director, 《周禮 •大司樂》, is presented, with, right away, the following point, by the rhythm of six: "以樂德教國子，中、和、祇、庸、孝、友；以樂語教國子，興、道、諷、誦、言、語 (he teaches the State sons the virtues of music: middle, harmony, respect, constancy, filial piety, friendship; the modes of musical language: incentive, ineffable, allusive, incantatory, enunciative, narrative)". This passage is followed by the statement of a progression into six steps showing that the two tone-scales fit together by reverse motions. This is implicit in the description of the linking of three steps, which correspond to the three kinds of ceremonies (offertories to the spirits of the three orders: 祭 *ji*, 亨 *xiang*, 祀 *si*), of a music in relation to instruments (奏 *zou*), singing (歌 *ge*) and dance (舞 *wu*): "乃分樂而序之，以祭、以亨、以祀".

乃奏黃鍾，歌大呂，舞雲門，以祀天神；
乃奏大蔟，歌應鍾，舞咸池，以祭地示；
乃奏姑洗，歌南呂，舞大磬，以祀四望；
乃奏蕤賓，歌函鍾，舞大夏，以祭山川；
乃奏夷則，歌小呂，舞大濩，以亨先妣；
乃奏無射，歌夾鍾，舞大武，以亨先祖。

Play *huangzhong* (*do*), sing *dalü* (*do#*), dance 'yun men', in celebration of the spirits of heaven;
Play *taicu* (*ré*), sing *yingzhong* (*si*), dance 'xian chi', in sacrificing to the spirits of earth;
Play *guxian* (*mi*), sing *nanlü* (*la*), dance 'da qing', in celebrating the ancestors;
Play *ruibin* (*fa#*), sing *hanzhong* (*sol*), dance 'da xia', in sacrificing to the mountains and streams;
Play *yize* (*sol#*), sing *xiaolü* (*fa*), dance 'da hu', in offering to the deceased;
Play *wuyi* (*la#*), sing *jiazhong* (*mib*), dance 'da wu', in offering to the ancestors;

The statement lists six steps related to instruments (奏): 黃鍾, 大蔟, 姑洗, 蕤賓, 夷則, 無射, that is to say *Do*, *Ré*, *Mi*, *Fa*$_\sharp$, *Sol*$_\sharp$, *La*$_\sharp$ (ascending whole tone scale), and six steps related to songs (歌): 大呂, 應鍾, 南呂, 函鍾, 小呂, 夾鍾, that is to say *Ré*$_\flat$, *Si*, *La*, *Sol*, *Fa*, *Mi*$_\flat$ (descending whole tone scale, complementary to the previous one); dances (舞) are mentioned, successively, as follows: 雲門, 咸池, 大磬, 大夏, 大濩, 大武. The *lü*-s with their old names, 函鍾 and 小呂, correspond to 林鍾 and 仲呂 in the later common names, which may be deduced from the standard chromatic scale. 圜鍾 *yuanzhong* is not mentioned, but some later commentators give it as 夾鍾 *jiazhong*, which has not been proved and is perhaps a result of deductive reasoning. The latter assumption is debatable, as we will see at a later stage with our own assumption regarding the solution to the musical statements of the 周禮 *Zhouli*. The system may be described as follows (Tabs. 1 a–d, reading from right to left).

---

4   All the texts related to music written after the 3rd and 2nd centuries BCE take as a basis the musical system stated in the texts mentioned above (禮記 *Liji* [Book of Rites], 史記 *Shiji* [Historcal Records], 呂氏春秋 *Lüshi chunqiu* [Springs and Autumns of Lü Buwei] and 淮南子 *Huainanzi* [Book of the Prince of Huainan]), quoting and commenting them at great length except for the 周禮 *Zhouli*, scarcely quoted and without comments about what is obscure. For example, in the 後漢書 *Hou Hanshu* (《志第一•律歷上》), it is said "以黃鍾為宮，太蔟為商，姑洗為角，林鍾為徵，南呂為羽，應鍾為變宮，蕤賓為變徵" (*do* for the tonic, *ré* for the second, *mi* for the third, *sol* for the fifth, *la* for the sixth, *si* for the sub-tonic, *fa#* for the sub-fifth), that is to say the five notes of the pentatonic (五聲 *wusheng*) with the two supplementary (變 *bian*) for the heptatonic in their standardized naming and the standardized enunciation of their relation with the twelve pipes (律呂 *lülü*).
5   The flute is also mentioned, under its old name (籥), as an instrument category.
6   圜 corresponds to what is circular, to the sky, the round vault of heaven, in comparison to 方, corresponding to the squared earth (天圜地方).

Taking into account the oldest bells arranged in two separate whole-tone scales on the Marquis Yi chime bells[7] or remembering the mention of a reduction to 25 strings of the 50 string zither by Fuxi, it would make sense to think that the reduction to one octave or the interlocking in twelve *lü*-s occurred later than the distinction into two separate *lü*-s 律 and 呂.

The 律呂 *lülü*-s were subject to various presentations in the course of time.

A Korean book by 丁若鏞 Chǒng Yagyong (1762–1836), regularly re-edited, presents this passage[8] in a non-standard socket (Tab. 2 a).[9]

Such a display, which seems erroneous, may be interpreted as a linear reduction of a dual circularity in which the two courses are considered as independent: one ascending (*do, ré, mi, fa$_\#$, sol$_\#$, la$_\#$*) and the other descending (*ré$_b$, si, la, sol, fa, mi$_b$*) with, for the old values (圜鍾, 函鍾 and 小呂), the values (夾, 林 and 仲) attributed; or even (Tab. 2 b) as the projection of a spiral movement (with a writing using, like the author's, only the first character for each name of *lü*, which is sufficiently distinguishing).

Besides, 陈克秀 Chen Kexiu puts them in connection with the twelve earthly branches (十二支 *shi'er zhi*)[10] and the tradition established later, giving a continuous progression by semitones, as follows (Tab. 3).

In ancient times, in Sumer and Babylon, then in Greece and also in China, certain intervals have been proscribed: triple whole tone (tritone), subsequently named 'Diabolus in musica' in the West,[11] and the triple third (or triple ditone), which confronts the incommensurability of the octave.[12] The pentatonic system avoids the tritone at the third step (after twice a tone) by increasing it with a tone and a half, while the heptatonic system avoids it by decreasing the third step with a semitone.[13] This leads to a fork angle after the third from a *lü* to the other (which perhaps gave its name to the third note of the system, '角'): the ditone {宮 *gong*-角 *jue*} is vector director of the pentatonic (it gives its position and direction) and it runs on the male (律) *lü* while the fifth and sixth are on the other, female, (呂) *lü*. It is therefore essential to take simultaneous account of both *lü*-s 律呂.

Thus, this crossing of the obstacle by a tone and a half led to a movement of the Chinese pentatonic scale on both *lülü*-s and in alternately ascending (read from right to left, from *do* to *la$_\#$*) or descending (read reverse from *si* to *ré$_b$*) (Tabs. 4 a–c).

Apart from the furthest notes (黃 hands over to 應, *do* replaced by *si*), there are no changes of pitches (太, 姑, 林, 南, *ré, mi, sol, la*) even if there are changes in their function (their name in 五聲 *wusheng*): 姑 which was 角 becomes 徵, and so on. After this double movement (陽 *yang* and 陰 *yin*), the next progression is a whole-tone higher (宮 on 太) (Tab. 4 b).

But it is also possible to swivel, still through the mobility of a single note, by keeping the arrival note (南) and replacing (for 角 *jue*) 姑 *mi* by 仲 *fa*, that is to say a mutation at first by the centre rather than by the periphery (or furthest notes), as follows (with the same departure point) (Tab. 4 c).

Thus, the progression may move forward in a descending way (黃 *do*, 無*si$_b$*, …), after the double movement (one reverses the other). Therefore, it seems that one must pass through the centre to reverse flows, which happens periodically.

The 律呂 *lülü* system is *in fine* equally tempered in which we no more distinguish *do$_\#$* from *ré$_b$*, whereas a former system might have, through ascending and descending scales, assumed the indivisibility of a whole tone into two equal parts. Subsequently, we will try to take into account the variety of possible readings, for instance – but not systematically – by using 'sharp' for an ascendant reading and 'flat' for a descending one. There is a Chinese notation adapted to this situation, which uses either 高 *gao* or 下 *xia* (Tab. 5) for the latter notes of the heptatonic system 工尺 *gongche* – which avoids the tritone by braking and introducing the semi-tone – when it is put in correspondence with the 律呂 *lülü* system (Tab. 5).[14]

Si$_b$ is indicated by lowering *si* with *xia* (尺下), *la$_b$* (上下) and *ré$_b$* (凡下) as well by lowering *la* (上) and *ré* (凡). The *raison d'être* of 五 (number 5) and 六 (number 6) is explained in the same paper and, among others, 四 (number 4) and 合 (harmony) are not characters to which it is possible to append 下 *xia*. *Fa$_\#$* (句 *gou*) has here a particular role of non-active pivot.[15]

---

7 See Journeau 2008b, 505.

8 Chǒng 1989, vol. 13, 414.

9 This book, written at the beginning of the 19th century, proposes, in the chapter of compilations related to music in old texts (in particular, the 周禮 *Zhouli*), some representations, often atypical, of the chromatic succession of *lülü*-s pitch-pipes and of its setting in correspondence with the pentatonic (*wusheng*) or heptatonic (*gongche*) systems: see pages 451, 475, 484 (with a copy error: 大 instead of 黃), 522, 526, 540, 588, and so on. Juxtaposed, they seem both erroneous and contradictory, but this shows above all the extent to which these statements may be understood in multiple ways, but without certainty about their true meaning.

10 Chen 2011, 15.

11 See, among others, Poizat 1991.

12 The octave is not divisible into two equal parts, which leads to the pre-eminence of the fifth and the fourth.

13 I showed that this interval was known and managed in this way in ancient times, that is to say it is the basis of a mutation through the process of metabole: see Journeau 2007a, 121–123.

14 See the details in Journeau 2008b, 491.

15 It is the same in Sumero-Babylonian antiquity, with a central note, very important, dedicated to the god Ea (see my Ph.D. thesis on the *qin* zither, Université Paris-Sorbonne, 2003, 136).

3 The Three Obscure Statements of the *Zhouli*

In the same chapter 《周禮 •大司樂》, after the presentation of this musical framework where the 律呂 *lülü* system is considered as a couple of two whole-tone scales and the Chinese pentatonic system by four (宫, 角, 征, 羽) of its five notes, three statements occur that seem obscure, but they may mention, without saying so explicitly, a kind of musical metabole close to the one explained in my articles.[16]

Statements to be clarified are:

(1) 凡樂，圜鍾為宮，黃鍾為角，太蔟為征，姑洗為羽.

(Ordinarily in music, '*yuanzhong*' for *the tonic, do for the third, ré for the fifth, mi for the sixth*)

(2) 冬日至[…] 凡樂，函鍾為宮，大蔟為角，姑洗為征，南呂為羽.

(at the winter solstice, '*hanzhong*' for *the tonic, ré for the third, mi for the fifth, la for the sixth*)

(3) 夏日至[…] 凡樂，黃鍾為宮，大呂為角，大蔟為征，應鍾為羽.

(at the summer solstice, *do for the tonic, do$_\#$ for the third, ré for the fifth, si for the sixth*)

According to the results of my previous research on the musical metabole in antiquity[17] – by applying the principle of a chromatic progression actually constituted by two whole-tone scales embedded, 陽 *yang* and 陰 *yin*, represented here (Tabs. 6 a–b) with repetition of two notes to the octave – the display used in the present paper will be as follows ({宮 *gong*-角 *jue*} shown by a box).

(1) 凡樂，圜鍾為宮，黃鍾為角，太蔟為征，姑洗為羽

It is possible to read the first statement, (1) [凡樂，圜鍾為宮，黃鍾為角，太蔟為征，姑洗為羽], as a dynamic evolution in three steps: we assume {黃鍾 *huangzhong* = *do*} (the reasoning is the same regardless of the base) and we search for the time this 黃鍾 = *do* corresponds to the 角 third. We thus get 宮 *gong* (base of the ditone) on *la$_b$*. It would be the value of 圜鍾 (unlike the assumptions giving it as *mib*)[18] since the 1st term of the statement indicates that "圜鍾為宮". {宮 *gong*-角 *jue*} is the guiding vector of the 五聲 *wusheng*. It gives the position (the one of the reference note, 宮 *gong*) and the direction ({宮 *gong*-角 *jue*} ascending or descending). The end of the statement may be explained as follows (Tabs. 7 a–b).

One observes indeed that 角 becomes *do* (黃鍾 *huangzhong*), *do* stable five steps, three 律 *lü*-s *yang* and two 呂 *lü*-s *yin* (from *ré$_b$* in the *yin* phase above, before its disappearance in the *yin* phase

below). That is to say it takes the value indicated by "黃鍾為角" (2nd expression); at the next stage, 征 becomes *ré* (*taicu* 太蔟), from *mi$_b$*, stable in the same way before disappearance, taking the value indicated by "太蔟為征" (3rd expression); at the next stage, 羽 becomes *mi* (*guxian* 姑洗) from *fa*, as indicated by "姑洗為羽" (4th expression), stable in the same way. 宮 *gong* goes to *sol*, but in the following *yin* phase, as the 商 *shang* will do in the next *yin* phase, which does not explain, however, the absence of 商 *shang*, generally speaking, in these statements.[19] It is indeed absent from the general structure of the metabole indicated in this passage.

This first statement is generic: one observes it may be repeated, transposed a third higher several times. If one assumes that the value taken by 角 *jue* in this statement, *do*, remains in this stage while the other notes are mobiles and that this note would be named the one for the spring season,[20] then the present stage (beginning on *la$_b$*) may be considered as the one for the year *n*. The one beginning on {*Do, Ré, Mi, Sol, La, Do, Ré*}, with *mi* remaining the same three times, might correspond to the spring of the following year (*n*+1). Then, continuing the series, the one beginning on {*Si, Do$_\#$, Mi, Fa$_\#$, Sol$_\#$, Si, Do$_\#$*}, with now *sol$_\#$* remaining three times, might correspond to the 3rd spring (*n*+2).

Arriving at the 4th spring, the series would be the initial one as far as *la$_b$* equals *sol$_\#$* (which is actually not the case). We will see later that it is the *raison d'être* of the special naming of 圜鍾: the incommensurability of the octave is traditionally proved by the fact that the sum of three thirds does not correspond exactly to the octave, so that one goes on with a spiral rather than a renewal of the same circle. We will not further discuss the succession of years in this paper.

---

[16] I presented my reasoning in two different ways: one in Journeau 2007b, 526–527, and the other in Journeau 2007a, 121, both explaining the metabole in a process also related to the one of Eratocles: "The metabole is created through a process adjusting one note after the other which may be applied up as well as down by tightening (higher) or loosening (lower) a string half a tone […]. Such a process operates as well at one or the other ending part of the ditone [*gong-jue*]."

[17] See also Journeau 2007b, 518–519.

[18] When Chen Kexiu (Chen 2011, 19–20) finally turns to this point, but without a proposal to solve the three statements studied in my present paper, he takes as a basis the value *mi$_b$* for 圜鍾 *yuanzhong* (and attributes this assertion to Sima Qian), while adding that "the meaning of the naming *jiazhong* is a product of the calendar" (夾钟之名是緣于历法意义).

[19] Li Xueqin (Li 1989, 845–850) comments on this fact by quoting other texts rather than by putting forward a solution.

[20] It would be too early to study the relations between pitches and seasons as they are stated in later works because 征 and 羽 exchange their positions with the reversal of the 五聲 *wusheng*, and the 商 *shang* seems to be banished.

Let us go back to the closing of the year, between the end of year *n* (winter) and the beginning of year *n*+1 (the next spring).

If the equation for the beginning of the next spring is *{Do, Ré, Mi, Sol, La, Do, Ré}*, it must be the conclusion of the process of winter, which seems to express the second statement (冬日至):

(2) 冬日至…函鍾為宮，大蔟為角，姑洗為征，南呂為羽

For winter, one considers that the steps are *yin* (movement of the 宮 *gong*) and that the reading order of the succession of the notes of the pentatonic 五聲 *wusheng* is lowering.[21] There are indeed four possibilities which cross both directions of the vector director and the two phases 陽 *yang* and 陰 *yin*. A sequence appears able to meet our need in order to satisfy the statement and the arrival in the following spring, justifying what might otherwise be a copy error for the 姑洗 *lü* allotted to 征. It is the phase which starts with a 宮 *gong* taking the value *Sol* and a 角 becoming *ré* from *mi*$_b$ (Tabs. 8 a–b).

The shift from *si* to *mi* is the adjustment required to move to the next year with a new cycle, which again applies the statement (1).[22] It corresponds to the alternation in the process indicated above.

The third statement of *Zhouli*, for the summer solstice (夏日至), corresponds to the transition from summer to autumn, therefore also to a certain rollover (less natural than the previous one because it will lead to introducing a fifth season):

(3) 夏日至…黃鍾為宮，大呂為角，大蔟為征，應鍾為羽

At the end of the spring season, the position was "黃鍾為宮" and here, according to the metabole process, it goes on with (Tab. 9 a).

But a reversal happens (*yang* phase but descending *wusheng*) and it is 征 arrived on *fa*$_#$ (which becomes 宮), which wings on *ré* (the direction of *wusheng* changes from {*ré, mi, fa*$_#$*, la, si*} to {*fa*$_#$*, mi, ré, si, la*}): "大蔟為征".The next stage (Tab. 9 b) pursues the process so that 角 *jue* resulting from the reversal, *ré*, goes on *do*$_#$: "大呂为角".

To be precise, in such a configuration, 羽, which was *la* at the beginning {*do, ré, mi, sol, la*} and remained the same at the next stage in the reversal {*fa*$_#$*, mi, ré, si, la*}, then turned toward *si* (either directly or through the *la*$_#$), which explains "應鍾為羽", because of a double reversal (direction and phase) in the passage between summer and autumn, like the transfer between *si* and *mi* in the passage between winter and the next spring, with a shift that might have given rise to a 5th season. Solstices are special moments and this oscillation can be experienced as a time 'spread' in a duality 6–7 for the first reversal and 12–1 for the second[23] as explained in (Tabs. 9 c–d).

This should flow to a cycle 陰 *yin* with an ascending 五聲 *wusheng*, that of autumn, before finishing cycle *yin* with a descending *wusheng*, that is winter, see statement (2). Note here the role of key pivot for *fa*$_#$, the central note as the *gong* is the centre.

4 Synthesis

During cycle *n*, '宮' is generated by the end of cycle *n-1* on a swing (from below or from above, as specified for the summer solstice; we will see the significance of this later).

This state can explain that *mi*$_b$ (夾鍾) has been set to 圓鍾, a name that would correspond in fact to a function, thus a mobile note and not a fixed *lü*, referring to a note changing each year: it becomes *la*$_b$ at the beginning of year *n*.

This movement of total failover, from *yin* to *yang* phase and from ascending to descending direction, can be represented as a movement back before going forward, the countdown in the heart of the spiral upward on one side and down on the other (Tab. 10).[24]

The reversal by revolving via *mi*$_b$ toward a 五聲 *wusheng* oriented by a guiding vector {宮 *gong*-角 *jue*} on *la*$_b$-*do* gives the position and the direction for the start of the new cycle.

The progress of a global cycle can be represented as follows (Tabs. 11 a–b).

This presentation, which shows two patterns on the whole-tone scale with an interval of one tone and half as hinge (from the final *fa*$_#$ of the phase on *yang* 律 *lü*-s to the initial *la* of the phase on *yin* 呂 *lü*-s), would correspond to a period prior to that of concordant texts from the 3rd century BCE on a progression by semitones according to the months of the calendar. In both cases, the fundamental of the pentatonic (宮 *gong*) traverses the twelve 律 呂 *lülü*-s within 12 months. In the case of the 周禮 *Zhouli*, one observes that over a season, as shown (Tab. 7) in the interpretation of statement (1), nine *lü*-s have been activated, and at the 6th stage twelve *lü*-s have already been used: 夷無黃 夾仲 then 太

---

21   On that subject, see Journeau 2008b, 497–498.

22   It happens that it corresponds to the assumption stated in my thesis (pages 113–128) that the 12th step of a cycle is the 1st of the following one (one goes from 11$_n$ to 1$_{n+1}$).

23   Some sundials proceed in this way (mirror-pivot without any other noticeable movement).

24   This is a conjunction also experienced in artistic acts in which, in order to smoothly conduct an inversion of direction with the bow or the brush, the reverse movement must begin before the end of the one underway, by reversing the wrist before the hand in the case of a violinist, and the tip before the rest of the brush for a calligrapher.

and 林; 姑 and 南; 蕤 and 應; finally 大. The same is true for the path on the 呂 *lü* (*yin*) that will use, according to a different path, also 12 律呂 *lülü*. Therefore, maybe there is a need to make 24 *lü*-s into two sets in order to deal with a year, in the same way that there is an increase in the number of strings on a zither to facilitate playing.

This reasoning reveals the need for periodic shifts. What is at stake is maybe the avoidance of the tritone, which is spanned by the pentatonic scale (in an horizontal reading) and of the triple third (triple ditone) in the progression on the 律呂 *lülü*-s system (in a vertical reading), but one may also observes that, whatever the *lü* taken into consideration, the process {宮 *gong*-角 *jue*} seems to complete the full circle after six *lü*-s (in equal temperament). The course on *yang* 律 *lü*-s begins with {*La♭ (Si♭) Do Mi♭ Fa*} (夷無黃 夾仲) and finishes on {*Fa♯ (Sol♯) La♯ Do♯ Ré♯*} (蕤夷無 大夾), the following pace corresponding to the initial pentatonic state: *Sol♯ (La♯) Si♯ Ré♯ Mi♯* (夷無黃 夾仲), that is to say, through enharmonics, *La♭ (Si♭) Do Mi♭ Fa*. This is why an adjustment is necessary to go further on. The necessity of periodic adjustments is known; it is already included in the statement about the generation of 律呂 *lülü*-s by the 三分損益 *sanfensunyi* method.[25]

By comparing the orders of calendar succession in the statement of the 周禮 *Zhouli* (of uncertain date) with the ones of the "月令 *Yueling*" (chapter on the calendar) of the 禮記 *Liji* (Book of Rites) dated around the end of the Warring States, of the 呂氏春秋 *Lüshi chunqiu* (Springs and Autumns) by Lü Buwei (ca. 291–235 BCE), and of the 淮南子 *Huainanzi* by the Prince Liu An (179–122 BCE), it is possible to make visible either a basic difference or a common principle of shifting (Tab. 12).

The above presentation is based on the one hand (left side) on the interpretative reading of the 周禮 *Zhouli* statements with alternating ascending and descending readings of the pentatonic *wusheng* (by three months or season), itself alternatively circulating on the 律 *yang* and 呂 *yin lü*-s (by double season or half-year, which is also true for six double hours of the day and the same for the night);[26] on the other hand (right side), on the reading of other books in which the two alternations (of the *yang* and *yin lü*-s and of the ascending and descending directions) proceed by month (ascending 律 *yang lü* and descending 呂 *yin lü*). In both cases, there is a correspondence between the twelve 律呂 *lülü*-s and the twelve months, but not at the same pace and not in the same order. If the first approach is also true for the rhythm of alternation between day and night, taking into account six double hours for each, a change of scale yet happened afterwards with a reappraisal of the cosmological approach, obviously for the reason that the lengths

of days and nights vary. The 呂氏春秋 *Lüshi chunqiu* mentions specifically the moment where day equals night (chap. 2, 2nd month of spring / 卷第二, 仲春紀: 日夜分，則同度量). Such a change of scale induces one to take into account an alternation on a day-night rhythm, thus the alternation *yang-yin* at each step rather than every six steps. Nevertheless, the first approach, which might seem not to take into account this variability of length, inserted a variable part in its fixed scale (as well as the variability of the fixed pentatonic scale 五聲 *wusheng* in the way it proceeds in the 律呂 *lülü* system of reference). At stake are the shifts at the time of reversals, which may be different choices according to the given unit; one may indeed move forward or back more or less, which allows managing in different way a fixed scale which seems common. It seems indeed that in the same way the three systems – pentatonic, heptatonic and chromatic – articulate one with the other within the great Chinese musical system, the relations between various scales of time may be harmonized one with the other in a common part despite the specificity of a given scale.

According to the later statements considered here (in "月令 *Yueling*" of 禮記 *Liji*, 呂氏春秋 *Lüshi chunqiu* and 淮南子 *Huainanzi*), the same shifts happen, systematically, in a progression alternating a large forward pace (one and a half tone) then a backward one (a semitone) in the transition from one month to another, so that either system reaches the triton after three months (one season), but in a different way. In addition, an important difference from my point of view between the "月令 *Yueling*" on the one side and the 呂氏春秋 *Lüshi chunqiu* and the 淮南子 *Huainanzi* on the other lies in the statement regarding the 3rd month of summer: the former text deals with it in continuity with the two first months of the season (征, old naming of 徵 *zhi* and 林鍾 *linzhong lü*, so that 宮 *gong* note is absent: five notes but four seasons), while the two latter texts deal differently with it as a peculiar step: the 宮 *gong* note is present with a specific naming of *lü* (百鍾 *baizhong*). This is the awareness that at this time a phenomenon takes place beyond the regulation systematized by the "月令*Yueling*" (chapter on the calendar) of 禮記 *Liji* (Book of Rites), a regulation which is the simplest model to take into

---

[25] For a detailed explanation, among others and in French, see Granet 1988 [1st ed. 1934], 185–204; more recently, see Chen Cheng-Yih 1996, 44–52. For a synthesis with a comparative analysis in mind on a worldwide scale about the basis of music through numbers, see Kelkel 1988, 43–65.

[26] The old Chinese count also divides up the month into six times five days or three decades or twice fifteen days, always an interaction between two and three and, subsequently, the importance of six.

account one year through the enunciation of four configurations, four notes, four seasons, each divided into three parts, in a correspondence between the notes of the pentatonic system (*wusheng*) and the twelve pitch-pipes so that one of the five notes has no place in it, as happens here with 宫 *gong*. To solve the problem of five notes face to face with four seasons, the note 宫 *gong* (here) is put at the centre and corresponds to the fifth season (inserted at the end of summer) in the 呂氏春秋 *Lüshi chunqiu* (Springs and Autumns) by Lü Buwei and in the 淮南子 *Huainanzi* by Prince Liu An; the note 商 *shang* is here explicitly present. One may notice that a month of fifteen days is mentioned in order to take into account the fact that there are two intricate series.[27] However, in these books, which match each other, the names of the pitch-pipes are the well-known ones (圜鍾 *yuanzhong*, 函鍾 *hanzhong* and 小呂 *xiaolü* have disappeared) and the progression, as stated in these reference books and in the "月齡 *Yueling*",[28] seems to be by semitones, but the interpretation through the metabole principle seems *forgotten* (the oblivion of the ancient music, loss of filiation, is a leitmotiv of the following dynasties from that time forward).[29] Tables of seasonal and monthly correspondences presented by Chantal Zheng in the French translation of the *Huainanzi*[30] confirm a general use (of this monthly succession) at this time.

According to statements in the 周禮 *Zhouli*, a cosmogonic point of view, the solstices correspond to places of flipping, overthrow of the growing 陽 *yang* in descending *yang* to the 陰 *yin* in the next phase; the two periods of six correspond to the fact that for six months the Earth speaks to the Sky, and the following six months the Sky meets the Earth. From a mathematical point of view, the break after five steps corresponds to a rupture in the calculation of the "三分損益法" *Sanfensunyi* method. The offset in the transition from summer to autumn is here one and a half tones, the one from winter to spring is a semitone (which is right for the idea of developing the pentatonic and heptatonic to avoid the tritone).

But above all, there is the idea that the initial *lü* of a given year is not fixed. And, in the same way, a shift is necessary after three paces (three years), after a course of three ditones from the initial note (*la♭*, *do*, *mi* leading to *sol♯*), which will allow going over the twelve 律呂 *lülü*-s in four levels, making a cycle of twelve years: one of these positions would be the one giving rise to the presentation in the texts of the latter books. Thus, the approach in the 周禮 *Zhouli* appears to be cosmologically fractal, except that at that time, which was not perceived later, rhythms (alternations) and durations (of each alternation) are differentiated: it is not a matter of a unique model but of a common principle with multiple forms (declensions), that is to say with a vari-

able part depending on the unit considered. This is why, from a musicological point of view, considering these assumptions which help to understand what is enigmatic in the 周禮 *Zhouli* statements and why the oblivion of the ancient music was deplored through the ages for around 2500 years,[31] it seems the 周禮 *Zhouli* should be dated some centuries prior to the other reference books considered here.

As for the reason why the '商 *shang*' note is more or less absent in the 周禮 *Zhouli*, several hypothesis may be put forward. From a political and social point of view, some names are taboo for a while. Thus, there is a custom proscribing the use of the name of the new king during his reign. The removal of the '商 *shang*' note may have happened in order to mark the eradication of the Shang dynasty by the Zhou dynasty, which should be corroborated by the fact that the 周禮 *Zhouli* is attributed to Zhou Gong, brother of king Wu, the warrior who was the victor, that is to say in a period immediately after the defeat of the Shang dynasty. From a musical point of view, since other names in the *Zhouli* are, conversely, in use at this time but disappeared afterwards, it may correspond to a state of the musical system at this time. Actually, the '商 *shang*' note is not necessary for the reasoning presented here because it is inserted at the centre of the guiding vector considered (the ditone, the third, which is the interval of reference in earliest antiquity). But

---

[27] It would be too long to explain this here in a detailed manner: see Journeau 2015, 49–59, and two excerpts of Le Blanc – Mathieu 2003, respectively in the *Tianwen* 天問 chapter, 115–118 (R. Mathieu) and in the *Shize* 時則 chapter, 205–247 (C. Zheng): "Lorsque Dou indique *zi*, c'est le Solstice d'hiver, et la note correspondante est celle du tube musical *huangzhong* 'cloche jaune'. Au bout de quinze jours, il indique *gui*, [...] la note correspondante est celle du tube *yingzhong*, 'cloche résonnante'. Quinze jours plus tard, il indique *chou*, [...] la note correspondante est celle du tube musical *wuyi*, 'sans surgissement'. Quinze autres jours plus tard, [...] le *yin* qui excède réside dans la terre. C'est pourquoi l'on dit qu'il saute un jour, et que quarante-six jours après le Solstice d'hiver, c'est le Début du printemps"; "Au premier mois de printemps, [...] la note est le *jue*; le tube musical juste est *taicou*, [...]; Au second mois de printemps, [...] la note est le *jue*; le tube musical *jiazhong*, [...]; Au troisième mois de printemps, [...] la note est le *jue*; le tube musical *guxi*, [...]; Au premier mois de l'été, [...] la note est le *zhi*; le tube musical *zhonglü*, [...]".

[28] According to Chantal Zheng (Zheng 2003, 199, footnote 2): "Les chapitres intitulés *Yueling* furent ajoutés par Ma Rong (79–166) vers la fin de la dynastie Han. Pour plusieurs commentateurs, dont Zheng Kangcheng (127–200), le *Yueling* du *Liji* serait l'œuvre de Lü Buwei".

[29] See the monthly succession transcribed from a musical point of view in Journeau 2011.

[30] Zheng 2003, 202. As for me, I also realized a musicological interpretative reading of this book in the theoretical part of my thesis, Journeau 2003, 110–128.

[31] The high level of music at this time (2500 years before the present) has been proved by the discovery of the Zenghou Yi chime bells, 65 bells tuned according to a greatly perfected system in 433 BCE (see Journeau 2008b, 494–495).

the reference, what I call the guiding vector of the pentatonic system, became afterwards {宮 gong-商 shang}; that is to say, the division of the ditone into two whole-tones has been validated. The history of music is a history of fragmentation of sounds. In very ancient times, the intervals of reference were the octave, the unison, and the fifth, sometimes considered as the unison of male and female voices, then, present in the harmonics, the third.[32] The succession of the smallest intervals was at first the ditone (third) and the one and a half tone. Later came the direct consideration of the tone by scission of this ditone into two whole tones and the setting up of the pentatonic scale 五聲 wusheng (five sounds), which disturbed the correspondence between four notes and four seasons and the progression in the twenty-eight lunar lodges. This is why cosmogonic relations were reexamined at the utmost.[33] Besides, an issue briefly evoked in the 《樂記 Yueji》 is revealing from this point of view: "聲淫及商何也 (why are the sounds exaggerated and use the shang note?)";[34] which seems to indicate that this note has been introduced or reintroduced.

5 Conclusion

I wanted to propose in this article a new interpretation of the statements of the 周禮 Zhouli, using a 'hypothetico-deductive' mode that extends and develops my previous works published in the West, rather than a comment (the practice traditional in China). But it is a topical issue in Chinese publications, as proved by a recent edition of the 周禮 Zhouli commented by 丁若鏞 Chŏng Yagyong and by the article written by 陈克秀 Chen Kexiu.[35] The difficulties in clarifying certain statements of earliest antiquity have a common origin in one or the other tradition: there is a threshold above which theorists are no longer able to explain what it was at the time because there was a break of continuity, often by changing references. The one observed here between the beginning and the end of the 1st millennium BCE on the Chinese side might be similar to the one observed between archaic Greece and classical Greece in the same period. In the same way the 周禮 Zhouli has appeared for generations of Chinese people as enigmatic (still qualified in this way by Chen Kexiu "疑惑難解的文獻"), some Greek statements were qualified as obscure for centuries, by generations of theorists, for it was unthinkable, because of the pregnance of the reference system in use from the end of antiquity onwards, that another reference system might have existed, based on the double octave, or that a seven-stringed instrument might have been pentatonic before becoming, after Terpandre, heptatonic.[36] The temptation is then to assume copy errors, which is of course possible.[37]

Chen Kexiu quotes 朱載堉 Zhu Zaiyu:[38] "in the words of the elders on the music... There are errors" (古人言乐。。。。。故有錯誤);[39] he concludes "we, people of today, have no way of judging" (我们今天的人是无法评判其有无可能的). In my view, it is certain that we must consider the Chinese representations as particular projections, in a given system of reference (space and time), of a multidimensional principle; but I am at the stage of discernment (of what is true in a different context, or of what is an error in copying) and of uncertainty as long as the veracity of my assumptions has not been proved in other ways. So, I submit the assumptions presented in this article to specialists for future discussions on the evolution of music in the great civilizations of the past. As an example of the fruitfulness of ISGMA conferences, I can benefit here from the presentation made by Joseph Chen (Chen Cheng-Yih) about the structure of the Zenghou Yi chime bells: he underlines the use of gong, gong-jue then gong-zeng as a cycle through the third, and, in fact, the third after the third is out of the pentatonic naming (from the initial tonic); jue is the third of gong but the third of jue cannot be named with one of the pentatonic names (with the example of gong = do, {do, ré, mi, sol, la} is the pentatonic scale) because this third of the third would be 'sol#'. That is why another name, such as the one of this kingdom, 'zeng', is necessary. I said in this paper that "the first statement is generic: one observes it may be repeated, transposed a third higher several times" but this way of thinking the movable 'gong' (according to the choice of each kingdom) disappeared with the standardization of the musical system.

---

[32]   See Journeau 2008b, 99 and Journeau 2008b, 489.
[33]   But, anyway, the plurality of possible readings of a common principle is retained. On that subject, see the musico-cosmological interpretation I made in my thesis for such statements in the 淮南子 Huainanzi (Journeau 2003, 110–128).
[34]   See, in French, Journeau 2008a, 161.
[35]   Chong 1989; Chen 2011.
[36]   Theorists of Greek music thus infer, from what they understand in the reference texts (similar to what is at stake on the Chinese side), that Greek people were singing in quarter tones or that the term 'heptachordos' was synonymous with 'heptatonos' (See, among other sources, my paper, Journeau 2008b, note 5).
[37]   See footnote 9 of the present paper.
[38]   Zhu Zaiyu (1536, ca. 1610), musicologist, mathematician and astrologer, also developed the equal temperament (around 1596) and wrote the reference book of his time.
[39]   Zhu 2003, 7–8.

Bibliography

Biot, E.
1851　Le Tcheou-li ou Rites des Tcheou.

Chen, Ch.-Y.
1996　Early Chinese Work in Natural Science. A Re-examination of the Physics of Motion, Acoustics, Astronomy and Scientific Thoughts (Hong-Kong University Press).

Chen, K.
2011　中国音乐学,《也谈"奏黄钟，歌大吕"》 [A Research on "Play Huanzhong, Sing Dalü"], Musicology in China 2, 12–22.

Chǒng, Y.
1989　Yǒyudang chǒnsǒ 奧猶堂全書 [Compilation Yoyudang] (Séoul, Kyǒng'in munhwasa) (1st ed. 1979).

Granet, M.
1988　La Pensée chinoise (1st ed. 1934).

Guo, Sh. Q. – Kong, W. F.
2012　Probing Tone Measurement Technology in Ancient China. On a Basic Concept of the Music-Archaeological History of China, in: R. Eichmann – J. J. Fang – L.-Ch. Koch (eds.), Studien zur Musikarchäologie VIII, Orient-Archäologie 27, 229–240.

Journeau, V. A.
2003　La Cithare chinoise 琴 *qin* (古琴 *guqin*): Texte – Image – Musique (Ph.D. diss., Université Paris-Sorbonne).
2007a　L'Antique Cithare chinoise *qin*, un heptacorde pentatonique, est un archétype de la musique de l'antiquité, Akkadica 128, 117–134.
2007b　Musique de l'antiquité: la théorie grecque au regard de l'antique cithare chinoise *qin*, Archiv Orientalni 75 (4), 518–519.
2008a　Le Livre de musique de l'antiquité chinoise, 樂記 *Yueji*, configuré et traduit par Véronique Alexandre Journeau, Paris, You-Feng.
2008b　Musique de l'antiquité en Chine: quand 'soies et bambous' (cordes et vents) sont accordés sur les cloches, in: A. A. Both – R. Eichmann – E. Hickmann – L.-Ch. Koch (eds.), Studien zur Musikarchäologie VI, Orient Archäologie 22, 487–507.

2011　Musique ancienne versus musique nouvelle dans la Chine des Royaumes combattants, Conference on Sounds, Political Space and Political Condition: Exploring Soundscapes of Societies under Change (Topoi International Workshop, German Archaeological Institute, Berlin).
2015　Poétique de la musique chinoise (forthcoming).

Kelkel, M.
1988　Musiques des mondes: Essai sur la metamusique.

Le Blanc, Ch. – Mathieu, M.
2003　Philosophes taoïstes II. Huainan zi.

Li, X.
1999　Zhouli zhushu 周禮注疏 [Comments on Zhouli], Beijing daxue chubanshe 北京大學出版社, coll. Shisan jing zhushu 十三經注疏 [Beijing University Press, coll. Anthology of the 13 canons].

Poizat, M.
1991　La voix du diable, la jouissance lyrique sacrée.

Shao, X. J.
2012　A Musicological Study of Unearthed "Chu Gong Ni Bells", in: R. Eichmann – J. J. Fang – L.-Ch. Koch (eds.), Studien zur Musikarchäologie VIII, Orient-Archäologie 27, 83–87.

Zheng, C.
2003　Des règles saisonnières, in: Ch. Le Blanc – M. Mathieu (eds.), Philosophes taoïstes II. Huainan zi, 205–247.

Zhu, Z.
2003　Yueshu quanshu 《乐律全书》 [Complete Text of Musical Temperament] 25 (2), 卷二十五，第 214 册, 上海 Shanghai (1st ed. around 1596).

La#	Sol#	Fa#	Mi	Ré	Do
無	夷	蕤	姑	太	黃
射	則	賓	洗	簇	鐘

			大	應	南	林	仲	夾
			呂	鐘	呂	鐘	呂	鐘
			Ré♭	Si	La	Sol	Fa	Mi♭

Tab. 1 a The six steps distinguished in two series described in the 周禮 *Zhouli* (made by the author from the text).

無	夷	蕤	姑	太	黃
射	則	賓	洗	簇	鐘

應	南	林	仲	夾	大
鐘	呂	鐘	呂	鐘	呂

Tab. 1 b Reading of the two whole-tone scale series in reduction on an octave (there and back)
(made by the author from Tab. 1 a).

| 應	無	南	夷	林	蕤	仲	姑	夾	太	大	黃
鐘	射	呂	則	鐘	賓	呂	洗	鐘	簇	呂	鐘

Tab. 1 c Reading of the two whole-tone scale series in chromatic interlocking (from Tab. 1 b)
(made by the author from Tab. 1 b).

| 夾	仲	林	南	應	大	*	無	夷	蕤	姑	太	黃
鐘	呂	鐘	呂	鐘	呂	*	射	則	賓	洗	簇	鐘
Mi♭	Fa	Sol	La	Si	Ré♭	*	La#	Sol#	Fa#	Mi	Ré	Do

Tab. 1 d Reading of the two whole-tone scale series as two independent sets
(from Tab. 1 b) (made by the author from Tab. 1 b).

| 亥圜鍾	戌無射	酉小呂	申夷則	未函鍾	午蕤賓	巳南呂	辰姑洗	卯應鍾	寅太蔟	丑大呂	子黃鍾

Tab. 2 a Display of the succession of 律吕 *lülü*-s according to the 周禮*Zhouli* (Chǒng 1989, 414).
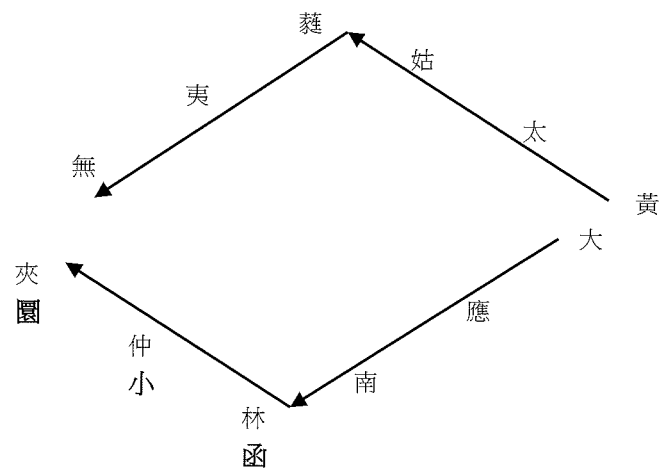
Tab. 2 b Reading of the display of the succession of 律吕 *lülü*-s (Chǒng 1989, 414).
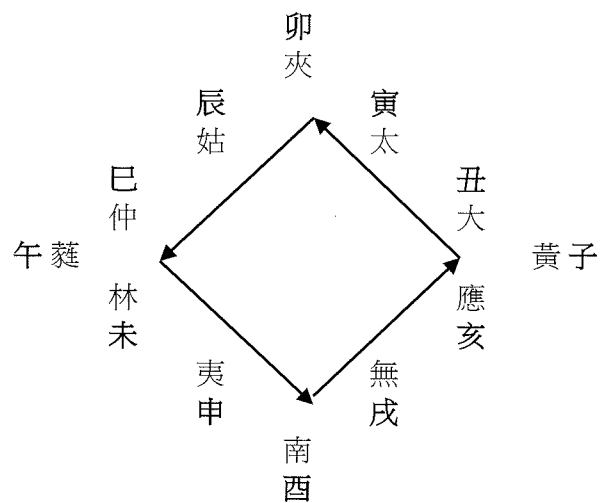
Tab. 3 Display of the succession of 律吕 *lülü*-s (inner circle) in concordance with the 12 十二支 earthly branches (outer circle) (after Chen 2011).
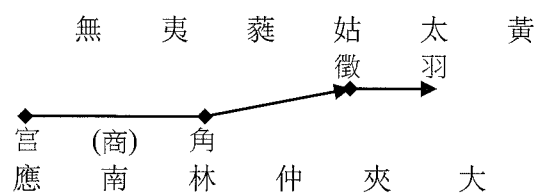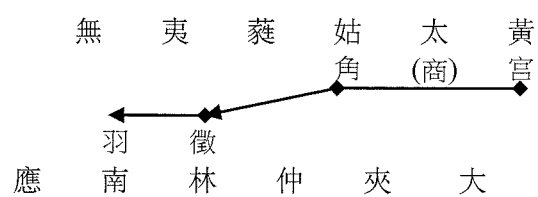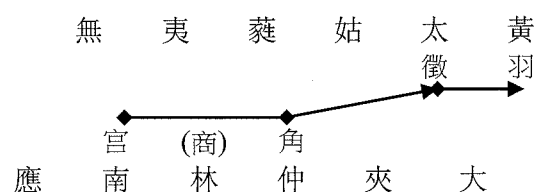
Tab. 4 a 五聲 *wusheng* ascending and descending alternating through mobility at the extremities (made by the author).
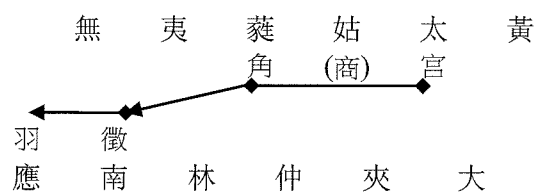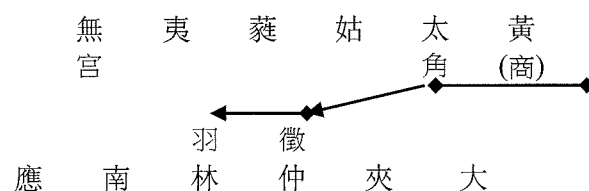

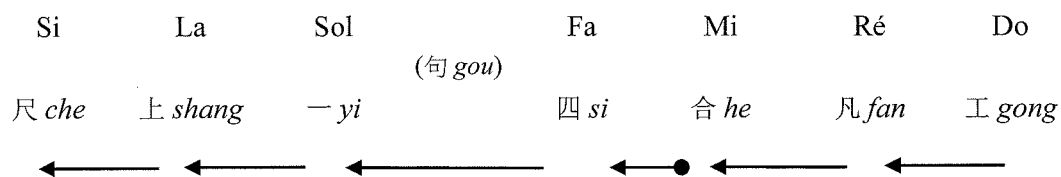Tab. 4 b Follow up of table 4 a (made by the author).

無　　夷　　蕤　　姑　　太　　黃
　　　　　　　　　角　　(商)　　宮

羽　　徵
應　　南　　林　　仲　　夾　　大
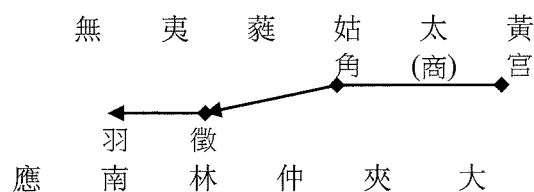
Mobility through the 角 *jue* while other pitches do not move (黃, 太, 林, 南, that is to say *do, ré, sol, la*)

無　　夷　　蕤　　姑　　太　　黃
　　　　　　　　徵　　羽
宮　　(商)　　角
應　　南　　林　　仲　　夾　　大

The next progression is one tone lower (through *si_b*)

無　　夷　　蕤　　姑　　太　　黃
宮　　　　　　　　　　角　　(商)

羽　　徵
應　　南　　林　　仲　　夾　　大

Tab. 4 c　五聲 *wusheng* ascending and descending alternating through mobility at the centre (made by the author).

Si	La	Sol		Fa	Mi	Ré	Do
		(句 *gou*)					
尺 *che*	上 *shang*	一 *yi*		四 *si*	合 *he*	凡 *fan*	工 *gong*

With alternative names for the ascending and descending phases:

工 *gong*	尺 *che*	上 *shang*	乙 *yi*		五 *wu*	六 *liu*	凡 *fan*
	下 *xia*	下 *xia*					下 *xia*
(Do)	Si_b	La_b	Sol		Fa	Mi_b	Ré_b
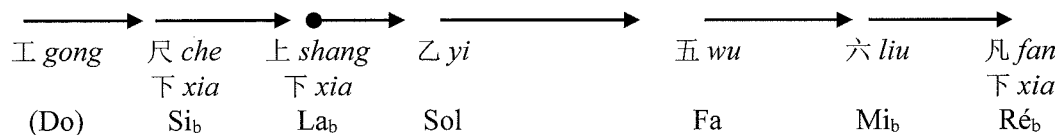
Tab. 5　Correspondence between the 工尺 *gongche* notation and the 律吕 *lülü*-s (made by the author).

	Réb	Mib	Fa			Lab	Sib		Réb	Mib
Do		Mib	Fa			**Lab**	Sib	Do		Mib
Do		**Mib**	Fa	Sol			Sib	Do		Mib
Do	Ré		Fa	Sol			**Sib**	Do	Ré
Do	Ré		**Fa**	Sol		La		Do	Ré
Do	Ré	Mi		Sol		La		Do	Ré
Si	Ré	Mi		**Sol**		La	Si		Ré
Si	**Ré**	Mi	Fa#			La	Si		Ré
Si	Do#	Mi	Fa#			**La**	Si	Do#
Si	Do#	Mi	Fa#	Sol#			Si	Do#
Si	Do#	**Ré#**	Fa#	Sol#			Si	Do#
	Do#	Ré#	**Fa#**	Sol#	La#			Do#	Ré#

Tab. 6 a Process of mutation through metabole in Western notation (made by the author).

Written with 律呂 *lülü* pitches and in a reduced form:

	大	夾	仲			夷	無		大	夾
黃		夾	仲			**夷**	無	黃		夾
黃		**夾**	仲	林			無	黃		夾
黃	太		仲	林			**無**	黃	太
黃	太		**仲**	林		南		黃	太
黃	太	姑		林		南		黃	太
應	太	姑		**林**		南	應		太
應	**太**	姑	蕤			南	應		太
應	大	姑	蕤			**南**	應	大
應	大	**姑**	蕤	夷			應	大
應	大	夾	蕤	夷			應	大
	大	夾	**蕤**	夷	無			大	夾

Tab. 6 b Process of mutation through metabole in Chinese notation (*lülü*).
Written with 律呂 *lülü* pitches and in a reduced form (made by the author).

征 羽 宮　　角 (征)

{Do,　Mi_b, Fa,　La_b, Si_b, Do,　Mi_b}　　　　　A^b (La_b)　調 *diao*

{Do,　Ré,　Fa, Sol,　Si_b, Do, Ré}　　　　　B^b (Si_b)　調 *diao*

{Do, Ré, Mi,　Sol, La,　Do, Ré}　　　　　C (Do)　調 *diao*

Tab. 7 a Process of statement (1) in Western notation (made by the author).

Written with 律吕 *lülü* pitches and in a reduced form:

征　　　羽　　　　宮　　　　　角

夾　　　仲　　　　　夷　　　　黃

太　　　　仲　　林　　　　無

　　姑　　林　　南　　　　黃

Tab. 7 b Process of statement (1) in Chinese notation (*lülü*). Written with 律吕 *lülü* pitches and in a reduced form (made by the author).

角　　宮 羽 征

{Do,　**Mi_b**, Fa, Sol,　Si_b, Do,　Mi_b}　　　　E^b (Mi_b)　調 *diao*

{Do, Ré,　**Fa, Sol, La**,　Do, Ré}　　　　F (Fa)　正調 *zheng diao*

{Do, Ré, Mi,　Sol, La,　Do, Ré}　　　　C (Do)　調 *diao*

{Si,　Ré, Mi,　**Sol, La, Si**,　Ré }　　　　G (Sol)　調 *diao*

Tab. 8 a Process of statement (2) in Western notation (made by the author).
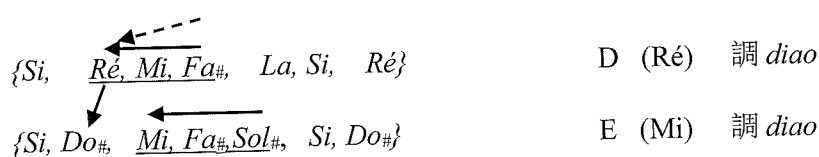
Written with 律吕 *lülü* pitches and in a reduced form:

角　　　　　宮　　　　羽　　　征

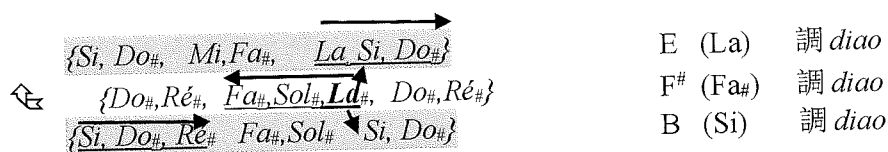夾　　　　林　　　無　　黃

太　　　仲　　　　南　　　黃

姑　　　林　　南　　　黃

太　　姑　　林　　　應

Tab. 8 b Process of statement (2) in Chinese notation (*lülü*). Written with 律吕 *lülü* pitches and in a reduced form (made by the author).

{Do, Ré, Mi,   Sol, La,   Do, Ré}   C (Do)   調 *diao*
宮   角   征 羽
{Si,   Ré, Mi, Fa#,   La, Si,   Ré}   D (Ré)   調 *diao*
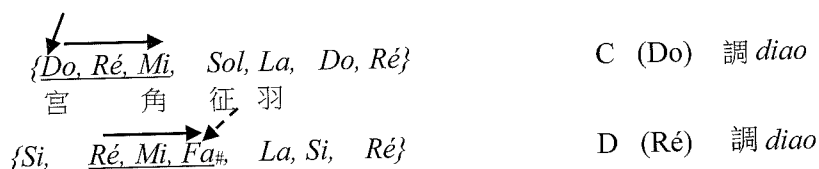
Tab. 9 a Initial phase of the process in progress in statement (3) in Western notation (made by the author).

{Si,   Ré, Mi, Fa#,   La, Si,   Ré}   D (Ré)   調 *diao*

{Si, Do#,   Mi, Fa#,Sol#,   Si, Do#}   E (Mi)   調 *diao*

Tab. 9 b Central phase of the process in progress in statement (3) in Western notation (made by the author).

{Si, Do#,   Mi, Fa#,   La Si, Do#}   E (La)   調 *diao*
{Do#, Ré#,   Fa#, Sol#, La#,   Do#, Ré#}   F# (Fa#)   調 *diao*
{Si, Do#, Ré#   Fa#, Sol#   Si, Do#}   B (Si)   調 *diao*

Tab. 9 c Final phase of the process in progress in statement (3) in Western notation (made by the author).

Written with 律吕 *lülü* pitches and in a reduced form:

宮   角   征   羽

黃   姑   林   南

太   蕤   南   應

大   姑   夷   應

大   姑   蕤   南

大   夾   蕤   無
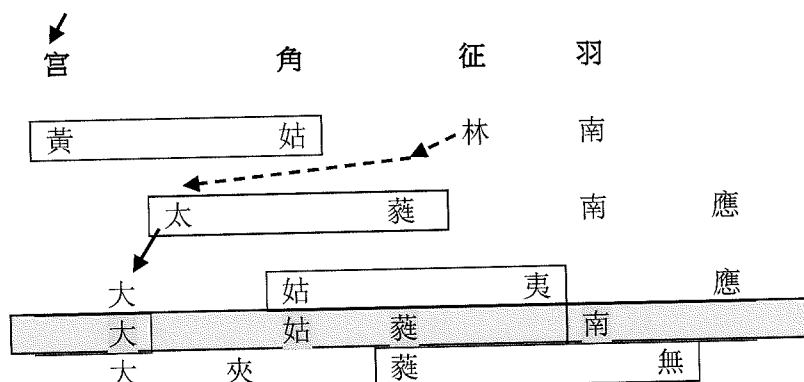
Tab. 9 d Process of statement (3) in Chinese notation (*lülü*). Written with 律吕 *lülü* pitches and in a reduced form (made by the author).

$\{\underline{Mi_b, Fa}, \ \ La_b, Si_b, \ \ \underline{\mathbf{Ré_b}}\}$ $\{\text{夾, 仲, 夷,無, 大}\}$
征 羽 宮 $\longrightarrow$ 角 ↙   夾 仲 夷 無 黃 ↗

$\{Mi_b, Fa, \ \ \underline{\mathbf{La_b, Si_b, Do}} \ \}$ $\{\text{夾, 仲, } \mathbf{夷,} \text{無, 黃} \}$
↑   ↑

$\{\underline{\mathbf{Mi_b, Fa, Sol}}, \ \ Si_b, Do \}$ $\{\mathbf{夾} \text{ 仲 林 無 黃} \}$
角 $\longleftarrow$ 宮 羽 征 $\longleftarrow$

Tab. 10 Change of year (made by the author).

$12^e_{n-1}=1^e$ pas   征 羽 宮 $\longrightarrow$ 角
$\{Do, \ Mi_b, Fa, \ \underline{La_b, Si_b, Do}, \ Mi_b\}$ A^b (La$_b$)   調 *diao*

2e pas
$\{Do, Ré, \ Fa, Sol, \ \underline{Si_b, Do, Ré}\}$ B^b (Si$_b$)   調 *diao*

3e pas
$\{\underline{Do, Ré, Mi}, \ Sol, La, \ Do, Ré\}$ C (Do)   調 *diao*

4e pas   角 $\longleftarrow$ 宮 羽 征
$\{Si, \ \underline{Ré, Mi, Fa_\#}, \ La, Si, \ Ré\}$ D (Ré)   調 *diao*

5e pas
⇩ $\{Si, Do_\#, \ \underline{Mi, Fa_\#, Sol_\#}, \ Si, Do_\#\}$ E (Mi)   調 *diao*

征 羽 宮 角
⇗⇩ 7e pas ↰ $\{Si, Do_\#, Mi, Fa_\#, \ \underline{La, Si, Do_\#}\}$ A (La)   調 *diao*
⇩ ↳ 6e pas ⇒ $\{Do_\#, Ré_\#, \ \underline{Fa_\#, Sol_\#, La_\#}, \ Do_\#, Ré_\#\}$ $F^\#$ (Fa$_\#$)   調 *diao*

8e pas
$\{\underline{Si, Do_\#, Ré_\#}, \ Fa_\#, Sol_\#, \ Si, Do_\#\}$ B (Si)   調 *diao*   (ou C^b / Do$_b$)

9e pas
$\{\underline{Ré_b, Mi_b, Fa}, \ La_b, Si_b, \ Ré_b, Mi_b\}$ D^b (Ré$_b$)   調 *diao*

10e pas   角 $\longleftarrow$ 宮 羽 征
$\{Do, \ Mi_b, Fa, Sol, \ Si_b, Do, \ Mi_b\}$ E^b (Mi$_b$)   調 *diao*

11e pas
$\{Do, Ré, \ \underline{Fa, Sol, La}, \ Do, Ré\}$ F (Fa)   正調 *zheng diao*

⇩
⇗⇩ 1e pas $_{n+1}$ ↰ $\{\underline{Do, Ré, Mi}, \ Sol, La, \ Do, Ré\}$ C (Do)   調 *diao*
⇩ ↳ 12e pas ⇒ $\{Si, \ Ré, Mi, \ \underline{Sol, La, Si}, \ Ré\}$ G (Sol)   調 *diao*

Tab. 11 a Cycle for a given year (*n*), the one given in the *Zhouli*, in Western notation (made by the author).

Written with 律吕 *lülü* pitches and in a reduced form:

Tab. 11 b Cycle for a given year (*n*), the one given in the *Zhouli*, in Chinese notation (*lülü*).
Written with 律吕 *lülü* pitches and in a reduced form (made by the author).

周禮 *Zhouli*

« 月令 *Yueling* »
呂氏春秋 *Lüshi chunqiu*
淮南子 *Huainanzi*

Tab. 12 Comparison in calendar succession between the *Zhouli* and later books (made by the author).

VML