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Is *nīd qabli* Dorian ?
Tuning and modality in Greek and Hurrian music*

The Hurrian hymns from about the mid-second millennium BC, found on cuneiform tablets from Ras Šamra, are currently the earliest extant example of written music. At the same time they are the most valuable proof that the so-called Babylonian musical system, known from theoretical texts from about 1800 to 600 BC, was not merely an abstraction of scribal lore, but stayed well connected with musical practice[1]. The image of a well-ordered diatonic system which emerges from these sources has revolutionized our understanding of ancient music and will, once fully appreciated, have an enormous impact on our general understanding of musical history.

Though the extant sources, scarce as they are, elucidate each other in a way that no one could have dreamed of, many questions remain open. The most crucial problem had long been that of the 'direction' of the scales: the sources provide us with a system of string names, intervals and tunings, but fail to make it clear which is the higher and which the lower end of the resulting scales. Yet even here the scholarly world seems now to have come to an agreement. Still the ultimate purpose, it often seems, of all archaeo-musicological cuneiform study is the performance of the best-preserved Hurrian hymn: plunging into the past by direct musical experience. However, though the meaning of most of the notation is understood at a certain level, the melody of the song remains in the dark, its rhythm unclear, and the connection of the lyrics to the notation hypothetical.

The purpose of this paper is not to put forth another hypothetical rendition of the hymn. Its auditory implications are small (but perceptible, as I venture to assert). And we will arrive at them only by the rather stony path of statistical considerations.

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1 Whether the texts N 3354 (Kilmer 1986) and/or BM 65217 + 66616 (Kilmer 1982), one earlier, the other later than the hymns, provide anything like notation is at the present unclear.

Many works on the subject of Near Eastern music print at least a translation of the most relevant music-theoretical cuneiform texts before dealing with them. However as this paper is not meant to provide an overview to be read independently of the earlier major contributions, it will suffice to describe shortly the most important structural features of ancient Near Eastern musical theory. Apart from the hymns, the most celebrated sources are:

1. The lexical text[2]: a list of string names, followed by the names of dichords and/or tunings. It is based on some nine-stringed instrument, presumably a lyre[3], which figures as the model instrument of music theory.
2. The 'mathematical' text[4]: a list of dichord names, relating to the same instrument.
3. The retuning text[5]: a description of the procedures involved in changing from one tuning to another (again on the nine-stringed instrument).
4. The song list[6]: from the musical section of a library, a list of the number of available songs of different types, several of them with their tunings.

Though none of these sources is complete, their relevant parts can be restored unambiguously from each other.

Their unifying element is those technical terms which appear as 'dichord names' in the 'mathematical text' and in the retuning text, as the names for instrument tunings in the retuning text and the song list, and with as yet uncertain meaning in the lexical text. So what is a dichord? Though not so complicated an idea in itself, it is not easily described, since unfortunately modern music theory has no appropriate concept. Structurally related in some, but not all, respects is the modern idea of a 'chord', such as the C-major chord. Everyone with even superficial musical training will know immediately what is implied by this name, but it is less easily defined. It consists of the notes c, e, and g, no doubt, but these may stem from different octaves, and accordingly also more than one of each of them may turn up: g-c'-e'-c''-g'' is as much a C-major 'chord' as is c-e-g (and the chord remains recognizable if its notes appear not at once but in melodic suc-

[2] U3011 (UET VII 126) + N4782 from Nabnītu 32. Kilmer 1965, 264; Kilmer 1971, 133–134; Kilmer 1982, 70; Wulstan 1968, 216–217; Crocker – Kilmer 1981; Shaffer 1981; Finkel – Civil 1982, 249–251; Duchesne-Guillemin 1984, 422; Lasserre 1988, 84–85; Krispijn 2002, 469; Shehata 2002, 495.

[3] For the identification of the *sammû* (UET VII 74 uses this name for the nine-stringed instrument) see Krispijn 1990, 6–7; Kilmer 2000, 116; Krispijn 2002, 467–468.

[4] CBS10996. Kilmer 1960; Kilmer 1965, 266; Wulstan 1968, 216; Kilmer 1971; Wulstan 1971, 366–367; Kümmel 1970, 253; Duchesne-Guillemin 1984, 422; Lasserre 1988, 85–86; Smith – Kilmer 2000, 127; Krispijn 2002, 470; Shehata 2002, 495

[5] UET VII 74 (=U.7/80). Gurney 1968; Kümmel 1970, 255–256; Wulstan 1971, 368; Crocker 1978; Kilmer 1982, 71; Kilmer 1983, 575; Duchesne-Guillemin 1984, 425; Lasserre 1988, 86–87; Gurney 1994; Krispijn 2002, 472; Shehata 2002, 496.

[6] KAR158 col. 8.45–52 (=VAT 10101). Kilmer 1965, 267. 138; Wulstan 1968, 223; Kilmer 1971; Wulstan 1971, 370; Duchesne-Guillemin 1984, 423; Lasserre 1988, 87–88; Krispijn 2002, 472.

cession). Much the same holds true for a Babylonian 'dichord', except that there are only two notes involved. If a dichord reads c-g in its canonical form (as the C-major c-e-g might be called canonical), the same dichord may as well be realized as g-c', or c-g-c', and so on. It will easily be recognized that in such a system there is no difference between a fifth (c-g) and a fourth (g-c'): as they add up to the octave, and notes an octave apart are treated as exchangeable, the intervals are equally exchangeable. Thus the Near Eastern dichords are by no means like our intervals, which are defined by distances of pitch: dichords, in contrast, are purely functional and thus highly abstract conceptions – at least from our point of view.

Just as Babylonian theory groups pairs of our fifths and fourths into a single idea, so it does with sixths and thirds: Major sixths and minor thirds, major thirds and minor sixths add up to an octave, and are consequently treated as the same thing. The intervals of seconds and sevenths would be candidates for a third type of pairing – but there are no terms for them. Obviously discordant intervals are of no interest for the Babylonian musician[7].

We have so far avoided giving examples of ancient names equated with modern notes. This is because of another complication inherent in the ancient system: in spite of what we have said about functional meanings, the ancient terms denote no fixed relationship. Since the 'dichords' are taken from the model of a certain stringed instrument, they are basically not relationships between notes, but between strings. And the pitch of each string (except perhaps that of the middle string) changes with the tuning of the instrument. Retuning the lyre implied shifting the pitch of one or more strings by the amount of a half-tone. A 'fifth' is therefore not always a fifth, but may be a tritone (a fifth minus the half-tone), a 'fourth' may turn into a tritone as well (a fourth plus a half-tone in this case)[8], and thirds and sixths appear in their major and minor variants.

Complicated as it may seem to us, such a system is eminently practical for lyre (or harp) players. Once they tune their instruments to the required scale, all they need to remember, or to communicate, are dichord names. Any given dichord was fingered identically in every tuning, although its pitches and consequently its musical function varied. What appears highly abstract and complicated to us, who decipher the system with the help of tables, was in fact pure convenience. Abstraction was confined to the realm of theory (if somebody cared). In practice, a set of fourteen terms sufficed to describe everything. Each of the seven strings

[7] I am well aware that the perception of concords and discords is to some extent culturally formed (and, as is less often stressed, depends on fine tuning: not all thirds are equal). The Babylonian position in a continuum of discord tolerance will become clear in the course of this paper.

[8] For the purpose of this paper, I am not going to distinguish between the 'augmented fourth' and the 'diminished fifth': the distinction, based on our idea of intervals, is lost entirely in the context of dichords.

within the octave was the starting point for one fifth/fourth and one third/sixth dichord – and that was it.

It is significant that this system was not oriented towards melody, as was ancient Greek notation and music theory, but to instrumental practice. Yet we have no reason to assume that Near Eastern song was any more polyphonic than in contemporary and later Helladic, Hellenistic and finally Roman Imperial music culture. The dominant instruments were the same in both regions: lyre, double pipe, and harp (the lute alone never enjoyed much popularity in the "Classical world"[9]). Nor is there evidence of fundamentally different playing techniques. The harp was plucked two-handed; pairs of differently bored pipes sounded two different pitches simultaneously; and the lyre was either plucked or strummed while dampening the unwanted strings with the left hand – which makes sense only if more than one string was meant to sound[10]. The heterophonic nature of instrumental accompaniment is expressly stated or implied by several ancient sources[11]. Still the extant Greek texts take it as granted that the ultimate aim of music theory is the description and interpretation of melody. And only melody was written down by the poet-composers, once the Greek system of notation was invented. To provide an adequate accompaniment was evidently left entirely to the instrumentalist – and it is significant that in most cases there was only one instrument. All this notwithstanding the fact that there was a so-called 'instrumental' notation which differed from the 'vocal' notation only in the shape of its signs. For we have no single instance (among about 60 extant fragments) where these signs are used to notate something like an independent accompaniment as implied by the textual sources[12]. It was rather used for purely instrumental pieces, where once more only the 'melody' was written down – though we must assume the performer again had to provide some more or less improvised accompaniment.

If one had wanted to write down the vocal melody of Near Eastern songs, the easiest way would have been to employ the string names (or numbers), perhaps with additional information when the melody left the compass of the instrument, doubling its notes in the upper or lower octave. Yet we know of no such endeavour. The only examples of notated Near Eastern music that are known so far, the Hurrian hymns, use the dichord names instead. The most straightforward interpretation of this fact is that the notation was meant for the instrumentalist, whose

[9] But cf. the exclusion of the lute from cult music in Mesopotamia; Kilmer 1997, 467.

[10] For the strumming technique cf., apart from the iconographical evidence, Martino 1997, 484–485.

[11] Cf. Barker 1995; Hagel 2004.

[12] Surprisingly enough, only the earliest example, the Orestes papyrus, can be interpreted in this direction (West 1992, 206–207. 284; DAGM 3), though the resulting accompaniment is rather rudimentary. See Psaroudakēs 2004 for a history of interpretations of this fragment.

training was naturally based on these dichords[13]. The melody would then have been known (or at least easily remembered with the help of the accompaniment). Even so it is more than likely that the melodic note, or the focal note of potential melisms or close sequences, was always part of the corresponding dichord. Nevertheless, there can be no unambiguous algorithm to extract the melody from the accompaniment, unless implausible restrictions are imposed on the system[14].

The fundamental difference between the Greek system, focussed almost entirely on melody, and the Near Eastern tradition, which gives prominence to the dyadic harmony of its dichords, is most easily explained by the different performance cultures, which form the respective contexts. In Greece, from earliest times on, the majority of occasions required a single instrumentalist, even if accompanying rather large choruses. So we already find the single lyre player on eighth century representations of dances, and the choral songs of classical tragedy

[13] The search for a neumic interpretation of the Hurrian notation (Wulstan 1971; Duchesne-Guillemin 1975; Duchesne-Guillemin 1977; Vitale 1980; Vitale 1982; Duchesne-Guillemin 1984; Duchesne-Guillemin 1988) was determined by the belief that no simultaneous two notes are acceptable before the middle ages (except perhaps drone accompaniments). The information that heterophony (whatever it is – it certainly involves simultaneous notes) is well-attested for ancient Greece is indeed slowly received (Crocker 1997, 202, blames the preoccupations and prejudices of classicists who generally do not understand their Greek. Surprisingly, to a classicist it seems that prejudices survive above all in musicological handbooks. With some good will, one will find the exceptions on both sides). Still it may sound heretical to many ("plus que contestable" Duchesne-Guillemin 1977, 402); but the courageous step of Kilmer 1974 to take an unprejudiced view, followed by Černý's instrumental interpretation (Černý 1988, 54; Černý 1994, 24; but cf. already Wulstan 1971, 376), finally formed the basis of what is now the prevailing paradigm; cf. Thiel 1977; Crocker 1978, 104; Arndt-Jeamart 1992; Crocker 1997; Krispijn 2002. West 1994, 173, criticizes Kilmer's interpretation on the grounds that in Ancient Greek music "there is no evidence at all for anything comparable to the kind of two-part motion that Kilmer extracts from the Babylonian notation". This holds true as long as the two parts are separated into a vocal and an instrumental line. If we take the notation as primarily instrumental, a staff rendition may still convey the impression of a 'two-part motion' to the modern eye; but dichord successions were certainly not perceived in that way by the ancient public, not more than we hear a modern accompaniment of strummed guitar chords as a six-part motion (cf. Crocker 1997, 201). Dichords blended into the impression of a single entity of sound: cf. the notion of blending (κρᾶσις) in Ps.-Aristot. *Prob.* 19.38. For the indifference of concordant intervals in respect to the melody cf. Aristides Quint. 1.6, p.10.1–3 W. I. For a summary of arguments for Near Eastern 'polyphony' ('heterophony' might have been the better term) see Kilmer 1997, 480. For criticism on the obsolete reconstructions of hymn 6 cf. Černý 1988, 51–54; Arndt-Jeamart 1992, 445–446; West 1994, 172–174; on West's transcription see below. Still there is no agreement regarding the relation between text and music – cf. the sceptic view of Arndt-Jeamart 1992, 445 –446, and whether the melody followed the dichord notation on a syllable-to-syllable basis or rather "oscillated following the known modal patterns over or round the key notes of it" (Černý 1994, 24; cf. Kilmer 1992, 105).

[14] Krispijn 2002, 474, tentatively assumes that the sung note was always the upper note of the dichord. This is not only a priori unlikely – it restricts the melody to five notes – but faces the additional problem that a dichord has an upper note only on a specific instrument; and there is no a priori reason to suppose that the mid-second-millennium Hurrian singer played the plausibly Sumerian instrument to which the terminology refers.

were, just as were the dithyrambs, sung to the accompaniment of only one double pipe. Instead of pompous accumulation of sound, virtuosity was held in esteem: rhythmic subtleties and melodic embellishments that could be achieved only by soloists[15]. Accordingly, virtuosi were able to acquire a prominent social status and also, due mainly to the public festivals, considerable wealth. In such a context notation could be useful only for the training of the singers (and only those of them who were not at the same time the composers: actors and members of choruses); the soloists had no interest in communicating the more complex aspects of their art, except in direct instruction from master to apprentice. Larger ensembles (though usually comprising not more than two types of instruments) performed together primarily at cultic occasions. There the music would have been entirely traditional, and thus there was again no need to write it down. On the other hand the different social structure of the Near East favoured larger ensembles[16]. Within these it must have been crucial to agree about the specific dichord with which to 'harmonize' the melody at any given time (while the actual notes and possible embellishments could be left to the choice of the individual players within the possibilities of their instruments). As far as we know, ancient Near Eastern orchestras never did play from the score[17]. But apart from practising together and playing by heart, there was the possibility of cheironomy, which is, according to the usual interpretation, shown on Egyptian iconographical sources[18]. As we have seen, the Near Eastern system would require no more than fourteen different hand signs. If the musicians were trained to choose their 'harmonies' accordingly, orchestral music could easily be improvised under the guidance of an experienced conductor.

Still there is little or no room for modulation in such a system. For that reason it will survive for a considerable period only in a mainly traditional, if not backward-oriented musical culture. But in Greek music history the melodic possibilities had soon become too rich to be contained within such a reduced harmonic framework. Not only were there the exotic non-diatonic tunings, which the Greeks themselves seem to have considered as inner-Greek innovations[19]. Insofar as these were only different heptatonic shades one would have been able to account for them in terms of dichords. But the archaic era already saw the first steps of an evolution towards more and more modulation, which culminated in

[15] For the Archaic and Classical era cf. Hagel 2004 with reference to Plato, *Laws* 812de; Ps.-Plut., *De musica* 1138b; 1141a.

[16] Cf. e.g. Collon 1997, 488–491.

[17] Cf. Černý 1988, 49, about the Hurrian hymns not having been scores to play from.

[18] For the Egyptian iconographical sources (though not the interpretation of the gestures) cf. Hickmann 1958; Hickmann 1961, 86–93; for Mesopotamia cf. Kilmer 1982, 77–78; Kilmer 1997, 475.

[19] Cf. note 43 below.

the so-called 'New Music' of the late fifth century[20]. Accordingly the dichordal system, if it was ever exported to Greece, must have died out there at a relatively early date, giving way to a native Greek consideration of musical structures, and a melodic notation.

Yet it is by no means sure to which extent the Near Eastern system was actually used for notation. The dichord names as they appear in the Hurrian hymns, though recognizable, do not maintain their standard Accadian form. In fact they may be interpreted as having gone through some time of purely oral tradition. When they come to be laid down again in Ras Šamra, apparently dictated to Semitic scribes by Hurrian singers[21], their underlying Accadian meanings seem to be entirely lost: they have become mere musical terms (just as the Italian meaning is lost together with the original pronunciation in the English instrument name 'piano' or the German term 'Dur'). A continuous scribal tradition presumably would have preserved the word forms better[22]. Moreover some terms that are used in the notation and seem to function as qualifications of certain dichords are in Hurrian language, which also testifies to the lack of an originally Accadian tradition. The city of Ugarit, a melting pot of cultures and credited with the invention of the only cuneiform alphabet ever used, might have been an ideal place for such a development[23]. So the Ras Šamra way of notating music might have been an innovation – though we must not give up hope that fragments of cuneiform music from other sites still await deciphering. In any case the Hurrian musicians were using the traditional Babylonian system of tunings and dichords, so the question whether the oral handing down of their musical practice was or was not accompanied by an unbroken line of scribal tradition is secondary to our enquiry.

Before we proceed it is necessary to understand one last complication of the Babylonian dichords: their directionality. As we have described them so far, as conceptually consisting of simultaneous sounds, direction plays no role. But as soon as one writes them down (which can be done only in relation to some stringing standard, as that of the nine-stringed lyre), one of the two components will

[20] Cf. Hagel 2000, 67–68. 81–87.

[21] Cf. West 1994, 171.

[22] While assimilations and weakened vowels as in *šalšatu* > *šaššate* might be explained within one line of script-accompanied linguistic evolution, a case like *titur išartu* > *ti-ti-mi-šar-te* can hardly: the final consonant appears not only dissimilated but is drawn to the second word in writing: the term was evidently not understood by the scribe as a combination of Accadian words but as a sound shape of its own right. Variant writings as *na-at-kab-li* beside *ni-it-kib-li* etc. contribute to the impression that the scribes were dictated terms which did not form part of their standard orthographic fund. Güterbock's statement (1970, 47) that the terms are "Hurrianized" in form has often been repeated but should be applied cautiously (I wish to thank Regine Pruzsinszky for her patient advice on these matters).

[23] The possibility of the notation being invented by the authors of the tablets is considered by Černý 1988, 50.

necessarily precede the other. A priori it seems natural to standardize the procedure and write either the upper or the lower component first. This is however not the method of the 'mathematical text'. Here the dichords are set out as follows (the particular layout and the graphical representation are intended to help in seeing the correlations and are not part of the cuneiform list):

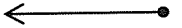
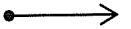
string numbers	dichord name	graphical representation
1 5	*nīš gabarî*	
7 5	*šēru*	
2 6	*išartu*	
1 6	*šalšatu*	
3 7	*embūbu*	
2 7	*rebūtu*	
4 1	*nīd qabli*	
1 3	*isqu*	
5 2	*qablītu*	
2 4	*titur qablītu*	
6 3	*kitmu*	
3 5	*titur išartu*	
7 4	*pītu*	
4 6	*serdû*	

Table 1. The dichord list of CBS 10996.

The dichords come in pairs which regularly share one string. The first one of each pair belongs into the fifths/fourths category, the second one into the thirds/sixths category. But the direction varies: sometimes the lower number is written first, sometimes the higher one. However, most of the rationale of the arrangement becomes clear quite immediately from the graphical representation given to the right of the table: it is governed by the starting string of the fifth/fourth dichords, which advances from 1 to 7. String 8 and 9 of the instrument on which the string names are based are not used: all dichords of the heptatonic scale can be expressed within the seven notes of one octave. The table starts with 'fifths'. Consequently once the third string is reached, another 'fifth' will exceed the range of seven strings and so the dichord direction has to be inverted to a fourth. It has been ob-

served that the direction of these fifth/fourth dichords is not chosen at random, but vital to the tuning process. To obtain a given tuning, one has to start with the homonymous dichord and to follow the other fifth/fourth dichords in the given direction[24]. For example, to tune the instrument to *nīš gabarî*, one starts from the dichord *nīš gabarî*, tuning it to a perfect fifth, from 1 to string 5. From string 5 the relevant interval is *qablītu*, a fourth to string 2, then with *išartu* from 2 to 6, *kitmu* from 6 to 3, *embūbu* from 3 to 7, and finally *pītu* from 7 to 4. In practice one need not think about any dichord name except for the first one: once the start is made, the rest is completely mechanical. At the end of the process, the remaining (seventh) dichord, in this case *nīd qabli*, from 4 to 1, is implicitly tuned to the unclear interval of a tritone. Tuning it to the appropriate perfect concord (here of a fourth) by altering string 1 (from which we have started), would bring the instrument into the homonymous tuning, *nīd qabli*. In this way a retuning cycle can be started from any given tuning. In the retuning text the cycle revolves around *išartu*, so that the central string could remain constant throughout[25].

[24] Kümmel 1970, 260–261.

[25] The pairs of dichord names and the same names qualified by a preceding *siḫip* in the lexical list has given rise to the hypothesis of 'plagal modes' in Mesopotamian music: Crocker – Kilmer 1981; Kilmer 1992, 103; Kilmer 1997, 473–475; for other explanations see Shehata 2002, 491. It must be emphasized that at the present stage this is pure speculation, and there are severe objections against the idea. Above all, the conception of employing different ranges from the diatonic scale with the same key note is not easily compatible with the paradigm of tunings, which builds on strings ('thetic values'), not functional notes. There seems to remain no connection between a 'plagal' tuning and its eponymous dichord. More natural is the idea considered by Černý 1994, 19, as giving a "certain plagality": identical tunings with different key notes. Against any identification with a given tuning or mode speaks the position of the *siḫip* terms in N3354 (Kilmer 1992; Kilmer – Tinney 1996): the tuning is primary to choosing notes and intervals, but in the text these come first (if the *siḫip* terms are colophons the text can hardly be an instruction). But should we not assume *siḫpu* to be more closely connected with *saḫāpu* as the technical term for tuning down a string (cf. Krispijn 1990, 5–6)? Cf. Arndt-Jeamart's explanation (1992, 435) of the expressions not as scales but as names for the procedure of down-tuning. Cf. also Černý's 'low tuning' hypothesis: Černý 1994, 19–20. Or should one compare, on semantic grounds, the Greek 'slackened Lydian' and (dubious) 'Ionian' (ἐπανειμένη λυδιστί Ps.-Plut., *Mus.* 1136e; ἀνειμέναν {Ἰαστὶ} μοῦσαν Pratinas fr. 6 Snell; Plato, *Republic* 398e χαλαραί; cf. Crocker – Kilmer 1981, 85), the former of which came to be perceived as connected to 'proper' Lydian in a plagal way, although its origins seem to lie in an independent mode (see Hagel 2000, 174–177)? At first glance the parallels seem striking: in both cases the name of a mode is qualified by the term normally used for tuning down a string. Greek 'tense Lydian' and 'Ionian' (συντονολυδιστί; σύντονον {Ἰαστὶ} μοῦσαν) would then correspond to Mesopotamian unqualified terms. On the other hand the Ionian mode vanished completely, which is hardly imaginable if it formed part of a cyclical tuning system. And at least in the case of the Lydian, 'slackened' is probably mainly an ethical term (Aristides Quint. 1,9 p.19.3–5 W. I.; cf. ἀνειμένος in Plato, *Republic* 549d; 573a; and especially Ps.-Aristoteles, *Physiognom.* 806b, where ἀνειμένη with ethical connotations stands in no opposition to ὀξεῖα 'high' as indication of pitch); and there are but the two instances in Greek literature as opposed to a (full?) system in Mesopotamia. After all, the combination of a term implying a scale, a tuning, or a pair of pitches with another term indicating a differentiation in pitch is so likely that no historic connection need be assumed.

The second intervals of the pairs in the list are less easily described. They have always one note in common with their counterpart of the fifth/fourth type, and they extend to the neighbouring note of the other one. Furthermore, the common note is always the second one of the respective fifth/fourth dichord. They have been called 'secondary' as opposed to the 'primary' tuning dichords; and this makes good sense. Problematic is their direction. In the first three pairs, the secondary dichords end with the common note, in the rest of the pairs they start from it. Now the difference between these two ranges does not lie within the secondary dichords. They are separated by the direction of the primary ones, of which the first three are 'fifths', the rest are 'fourths' with consequently reverted direction. Whatever interpretation one might suggest for this anomaly, it constitutes a clear break of symmetry, and such a break might a priori constitute a signal for intention: usually we like to maintain symmetric arrangements unless there is a reason not to do so. However the fact that this symmetry break occurs exactly at a boundary that is imposed by a structurally independent feature of the list must raise suspicion. At such a point the inversion need not indicate more but a failure to maintain the basic symmetry in the inverted context.

In the given frame of seven steps, the primary dichords, which comprise three or four steps, behave necessarily differently from the secondary ones, which consist of two or five steps: if inversion were governed simply by fitting into the frame, as it clearly is in the case of the primary dichords, the rules of inversion must be independent. On the other hand, secondary dichord inversion, as we have seen, is not governed by the pairing rule – or at least not in a consistent way. Under these circumstances it is quite unlikely (a chance of one in seven) that the structural break should coincide with the primary dichord inversion by chance. At the same time there is no explanation why they should coincide necessarily. Consequently we must accept that the structural break in the direction of the secondary dichords is most probably meaningless.

Once this is accepted, the following picture emerges:

1. The arrangement of the dichord list is based on the primary ones, whose sequence and direction are easily explained.
2. Each primary dichord is paired with a secondary one on the principle that both share the end point of the primary dichord, and that both add up to a second/seventh. This principle can be understood, but alternatives are possible and we have seen no underlying principle that determined the choice. So it would be fine to have another explanation for it, perhaps also rooted in the practice of instrument tuning[26].

[26] Smith and Kilmer (2000; cf. also Kilmer 1997, 472–476) have interpreted the secondary dichords as testing intervals in a process leading to a tempered tuning. I have however not found much structural argument behind this claim: why should the actual pairings of primary and secondary dichords serve this purpose any better than other ones (cf. Crocker 1997, 199)? In any case this paper will show that the idea of a Babylonian tempered tuning is hardly compatible with the facts.

3. The direction of the secondary dichords has no meaning in itself. Nonetheless they have to be written in one of the two possible directions. Whoever devised the list, tried to derive their direction from that of their primary dichords. Yet at the point where the primary interval direction changes, he failed to take this fact into consideration. Consequently the symmetry is broken – but as the distortion has no consequences, no one cared.

To transcribe the different tunings as nine note scales, we have only to determine whether the 'first' string is the highest or the lowest. Fortunately, as we have said, this question seems now rather settled on the base of organological and philological arguments: the counting starts from the highest string[27]. From my own experience with the nine stringed lyre I can add another argument in favour of this prevailing view. Since the higher notes (I use gut strings) give a much clearer sound than the lowest ones, it is perfectly natural to set up the tuning on the seven higher strings. The lower two ones are tuned much more easily to the octave of the highest pair than employed as intermediate notes in the tuning process. Consequently it would have been surprising if the list of the dichords, which is so intimately connected with the tuning process, should have used the less useful lowest strings[28].

Whether a transcription uses staff notation or modern note names, it must always be made clear that no implication about absolute pitch is intended. Moreover scholars have made quite different use of modern notation, depending on which aspect of the Mesopotamian system they wanted to demonstrate. When the different tunings are illustrated as they are created out of each other in the retuning process, sharps and/or flats have to be introduced: in this respect tunings are similar to keys. For each step in the retuning cycle we have to add or subtract one sharp or flat, depending on the retuning direction, and the rather arbitrary choice of a basic tuning. On the other hand, when the individual tunings are viewed as scales, it is more convenient to display each of them in the 'natural' key, as different ranges of white keys on the piano. Here tunings are treated as similar to modes, such as we are used to think about the major scale as starting with c and the minor scale with a (we will have to consider in a moment how much sense such

[27] This version was advocated first by Vitale (Vitale 1980, 42; Vitale 1982, 243–245), then corroborated by a new reading of the retuning text by Krispijn 1990, 15, and further supported by Arndt-Jeamart (1992, 431–432) and West (1994, 165–169); cf. now Kilmer 2000, 114.

[28] The directionality of the primary dichords was a matter of free decision (that had to be made at a very early point, and was extremely unlikely to be revised later on): to take the fifths as falling, the fourths as rising. Is it by accident that in the extant ancient Greek melodies the greater part of the fifths (56.6%) are falling, while the majority of fourths (58.2%) is rising? The difference is not very large (14.8%), but significant at the 5% level ($\chi^2=4.56$; $p=0.033$). A common tuning technique, many centuries old, might have exerted its influence on hearing conventions and so ultimately on melodic style. For Greek tuning in falling fifths and rising fourths cf. below with note 62 on the Invocation of the Muse.

a view on the Babylonian system makes at all)[29]. Solmisation syllables are generally preferable in such a situation, when only relations between notes within a diatonic scale are envisaged. However, in many countries even musicians are little familiar with them, so note names are no doubt more practical.

How to transcribe a tuning like, for instance, *nīd qabli*, which is used in the Hurrian hymns? Insofar it is first created by the primary dichords of the list, it can be written down as consisting of the seven strings used there:

7	6	5	4	3	2	1
f	g	a	b	c	d'	e'
FA	SOL	LA	SI	DO	RE	MI

Alternatively we can use the nine strings of the reference instrument. Thus we get the *nīd qabli* 'scale' as it is created in the retuning text:

9	8	7	6	5	4	3	2	1
d	e	f	g	a	b	c	d'	e'
RE	MI	FA	SOL	LA	SI	DO	RE	MI

Still we know of instruments with more than nine strings, both lyres and, of course, harps. We have no idea at all whether additional pitches were added only at the upper or the lower end of the scale, or at both ends; and if at both ends, to which extents. At least it is highly plausible that the shortest strings of the harps gave a higher pitch than any lyre string. But if the *nīd qabli* part of the tuning was embedded in surrounding strings extending the scale in probably both directions, was there any recognizable *nīd-qabli*ness preserved? Which leads us immediately to one central question of this paper: was there any modal value inherent in the Babylonian tunings[30]?

It has been said that *nīd qabli* corresponds to Greek Dorian[31]. Obviously the only basis for this connection is the fact that the highest string of the *nīd qabli* tuning is e = MI, which is at the same time the highest note of the Greek 'Dorian

[29] Our earliest source for a clear definition of these two approaches is Ptolemy. Unfortunately his concepts of note names 'according to position' (on a stringed instrument, and thus with approximately constant pitch) and 'according to (melodic) function' are usually not translated but rendered by the Greek terms 'thetic' and 'dynamic', which are extremely misleading and confusing to the novice in Greek musical theory. The same terms are introduced into the interpretation of Near Eastern tunings by Wulstan 1968, 221, as captions for his transcriptions of both types (criticized by Crocker 1997, 195).

[30] West 1994, 169–171 and 178–179, argues against such an identification.

[31] Crocker 1997, 195 (with reservations whether the equation is meaningful); Kilmer 2000, 114.

octave species'[32]. This line of reasoning may have seemed justified by the combination of the following two thoughts:

1. The lowest note of each Babylonian tuning is (as we have just seen) ill-defined.
2. The Greeks themselves thought of scales as descending.

The first sentence, however, is purely negative, and apart from our reservations that the upper note might be not much better defined once we use a different instrument[33], such a negative statement can by no means serve as the basis for a cross-cultural identification.

The second reason is no less problematic. Firstly, it equates the abstract notion of the octave species, which is at home only in ancient Greek music *theory*, with the idea of a scale or mode[34]. The mere endeavour seems to aim at establishing a connection to the famous ethical values often attributed to Greek modes. But as these apply only to the modes, not to the octave species, the attempt is misleading. Secondly, the idea that the Greeks 'thought of' their scales as descending in a way as we consider ours as ascending, though often repeated in the handbooks, is very ill-founded. Scales just sit there[35]; and so the Greeks seem to have taken them: there was no universally acknowledged direction of enumeration[36]. At the same time, it is an anthropological fact that more often than not melodies display a general downwards trend, just as speech melody does[37]. Consequently one might expect downwards enumeration to be favoured. The reverse direction is natural only if the lowest note is at the same time a focal note of the modal scale (most modal scales will have one rather low note as a preferred final, but not necessarily a high focal note). In this case, vocal upwards 'enumeration' probably coincides with a typical melodic opening, which allows an easy start. We do not know very much about Classical or earlier Greek scales; but it is likely that the coincidence of lowest note and focal note was far from universal.

[32] Where the *lowest* note of the Greek *octave* species is equated with the first of *seven* Mesopotamian strings, it is hard to find any justification: Kilmer 1982, 97; Kilmer 1983, 575; Kilmer 1997, 472. 475.

[33] Cf. the doubts, uttered already by Kümmel 1970, 261, whether the boundaries set by the nine strings are musically relevant.

[34] Cf. Winnington-Ingram 1936, 10–21; West 1992, 185–189; Hagel 2000, 165–168.

[35] Crocker 1997, 194.

[36] Examples for ascending enumeration are e.g. Kleoneides, *Harm.* 4, p.182–185 Jan (several times) and passim (Kleoneides stands firmly in Aristoxenian tradition); Aristides Quint 1.6, p.7–8 W. I.; Gaudentios, *Harm.* 6–7, p.332–336 Jan; and all the notational tables found in Aristides Quint. (p. 19–20; 24–27 W. I.), Alypios (p.368–406 Jan) and Gaudentios. West 1994, 167, correctly says that ancient Greek *notation* is descending: in the creation of the vocal notation the letters of the alphabet were applied to the signs of instrumental notation in an order that corresponds to descending pitch. Still they form no scale; and it is noteworthy that the last letter Ω resides on a structurally primary place, while the A is assigned to a 'double sharp' (*oxýpyknos*), which does not occur in the basic keys: evidence enough that the inventors did not simply 'conceive of their scales as descending'.

[37] Especially for Ancient Greek cf. Devine – Stephens 1994, 435–445.

We must conclude that, even if the Greeks should have 'perceived their scales as descending', this does not at all imply a structural priority of their highest notes. Greek modes, too, were defined by focal notes, rather low finals, and a hierarchy of melodic intervals[38]. All in all, it is no good idea to equate Near Eastern tunings and Greek octave species on the basis of their highest notes. Even so, in the special case of Dorian and *nīd qabli* there are arguments for a possible connection.

The musical revolution of the late Greek Classical period has obliterated almost all traces of former modal variety. The smooth Aristoxenian system on which the extant treatises are based is founded on identical, regular scales that can be realized on any semitone step within an octave – for that purpose, the semitone steps are regarded as equally tempered[39]. Modality has retreated into the realm of composition: choosing the tonal material out of the pool provided by the system, and using it appropriately[40]. Though the understanding of the principles of composition formed a part of theory as well[41], unfortunately no treatise has survived that goes that deeply into the matter. Thus we have only echoes of the early irregular, modal scales. The most informative source is Aristides Quintilianus, who transmits some scales which are said to be those Plato had in mind in the discussion of ethical qualities in his *Republic*. His Dorian reads as follows:

d e e$^{\uparrow}$f a b b$^{\uparrow}$c' e'

The note written as e$^{\uparrow}$ is situated about a quartertone above e and thus also a quartertone below f. This scheme of two quartertone steps below a ditone is typical for the enharmonic genus, which was dominant in the Classical era. The New Music obviously brought about the supremacy of the chromatic, which offered exciting possibilities for new modulation techniques[42]. Here the quartertones were replaced by semitones. In the Roman period the diatonic finally prevailed. Nevertheless, all three genera were known to have been relatively old[43]. The evolved enharmonic seems in fact to have been the youngest, having originated in the sixth or early fifth century BC, while no date of invention could be given for diatonic and chromatic music. So it is clear that there had always been diatonic

[38] Cf. Winnington-Ingram 1936, 1–8. 29–47.

[39] The Aristoxenian temperament has often, but wrongly, be regarded as adopted for the description of scales; e.g. Husmann 1961, 41–42. But Aristoxenos' genera are located within a continuum, so that equal temperament is of little or no use there. It is essential only for the cycle of keys; cf. Hagel 2000, 54–56; Hagel 2001, 86–88.

[40] The best example of this procedure is the tonal structure of the First Delphic Hymn, DAGM 20, which proceeds from an archaic scale to the rapid modulations of the 'New Music'. Cf. Hagel 2000, 38–87; Hagel 2002.

[41] Cf. e.g. Aristoxenos, *Harm.* 2.38, p.48.4–10 da Rios; Kleoneides, *Harm.* 1, p.180 Jan; Aristides Quint. 1.5, p.6; 1.12, p.28–30 W. I.

[42] Cf. Hagel 2000, 118.

[43] Cf. Ps.-Plut., *Mus.* 1134f; 1137e (based on Aristoxenos).

lyre tunings[44], even if the tables of the earlier theorists accounted only for the enharmonic genus, then held in the highest esteem[45].

If we convert Aristides' Dorian from enharmonic to diatonic, it can be transcribed as follows:

d e f g a b c' d' e'

This is prima facie nothing else than nine-stringed *nīd qabli* (if we do not hesitate to equate a tuning with a scale). But are we justified in substituting a diatonic for an enharmonic scale? Although both variants seem very unlike each other to our eyes, the names for respective notes are the same in both cases: to the Greek musical mind, they fulfil the same function. If one wants to clarify which pitch is meant, the genus must be expressly stated. A '*likhanós*' might be anything between f and g – only an 'enharmonic *likhanós*' is more or less clearly defined as an f, i.e. as lying two tones below central a[46]. The note names, which are originally derived from string names, support our hypothetical tuning[47]. Early tunings on the canonical seven-stringed lyre ranged from *hypátē* to *nḗtē*, from the 'topmost' to the 'bottommost' string. These terms of spatial orientation refer to the location of strings on the instrument, not to pitches (which were perceived as 'heavy' and 'sharp', not 'low' and 'high')[48]. Thus *hypátē* corresponds in fact to the lowest pitch, *nḗtē* to the highest. In early tunings there was already a span of an octave between *hypátē* and the 'Dorian *nḗtē*', with functional values that must be transcribed as e and e'[49]. As long as there were still only seven strings, this arrangement precluded the tuning of a continuous heptatonic scale. There was a gap in the upper range: the note, which later came to be known as *trítē*, 'third one', was missing[50]:

[44] Cf. Franklin 2002; 2002a.

[45] Aristoxenos, *Harm.* 1.2, p. 6.6–12 da Rios. It must be significant that the enharmonic is connected primarily with the double pipe, as the chromatic is with the (concert) kithara, and that several early theorists took the aulos as the model instrument. Cf. Hagel 2005.

[46] On the other hand, Aristoxenos derives the enharmonic *likhanós* (f) from the diatonic *parypátē* (f) (Ps.-Plut., *Mus.* 1134f–1135b). But this is only a reference to a pre-Aristoxenian historical account (cf. Hagel 2004); synchronically he leaves no doubt as to the functional equivalence of notes of similar name (e.g. *Harm.* 1.22–27, p.29.5–35.8 da Rios). Note that ancient Greek notation is also based on functional, not pitch equivalence.

[47] For the following cf. e.g. West 1992, 219–223. For a reconstruction of an eleven-stringed tuning, West 1992a, 26–27.

[48] For the history of spatial representation of sound in Greek, cf. Rocconi 2002.

[49] Ps.-Ar. *Probl.* 19.32; Nikomakhos, *Harm.* 9, p.252–254 Jan; Ps.-Plut., *Mus.* 1140f. Their function as the outer notes of two disjunct tetrachords is best illustrated by Philolaos, fr. 6.

[50] The terminology used by Philolaos in the late fifth century is still dependent on this 'defective' tuning: Philol. fr. 6; cf. West 1992, 219–220; Hagel 2005.

e	?	?	a	b	?	e'
hypátē topmost			*mésē* middle			*nḗtē* bottommost

By not later than the middle of the fifth century the number of strings on the professional lyre, the kithara, had been increased to nine. Thus the heptatonic octave could be completed by supplying the 'missing' note. And another note was added at the lower end of the scale[51]: *hyperypátē*, 'beyond the (old) topmost'. Regardless of the genus, this note was always tuned one tone below *hypátē*, taking its place in the harmonic framework a fifth below the central string and focal note, *mésē*[52]. The standard ('Dorian'?) tuning can thus be reconstructed with some confidence as

d	e	e$^{\uparrow}$–f	f–g	a	b	b$^{\uparrow}$–c'	c'–d'	e'
hyperypátē	*hypátē*	*parypátē*	*likhanós*	*mésē*	*paramésē*	*tritē*	*paranḗtē*	*nḗtē*

For the so-called 'moving' notes, which alter their position according to genus and tuning shade, their approximate ranges are given. For comparison with the exclusively diatonic scales of the Near Eastern system we must again take the diatonic variant – we remember that there was diatonic music during all this time –, which is

d	e	f	g	a	b	c'	d'	e'
hyperypátē	*hypátē*	*parypátē*	*likhanós*	*mésē*	*paramésē*	*tritē*	*paranḗtē*	*nḗtē*

So we arrive at exactly the same Classical Greek diatonic 'Dorian' lyre tuning in two entirely different ways, which permits us to have some confidence in the reconstruction. It seems as if Classical Greek lyres were at least sometimes tuned in a way that the Babylonian musician would no doubt have identified as *nīd qabli*. Can we suppose a direct historical connection, perhaps dating from the 'Orientalizing' period in Greek culture[53]? Tempting as such speculation is, it is

[51] So explicitly Boethius, *Inst. Mus.* 1.20, p.208 Friedlein.

[52] For the function of *mésē* cf. West 1994, 167 with note 13. For the *hyperypátē* cf. Hagel 2000, 89–93.

[53] So Franklin 2002a.

hardly reconcilable with the history of Greek tunings, as sketched above. If our tuning had a deficient precursor – and the fact is stated by independent sources – it cannot at the same time have been taken over from Near Eastern models, at least not at such an early date. In the fifth century, on the other hand, the 'Dorian' tuning was so well-embedded in the typically Greek system of the three genera, its evolution so reasonable, that the assumption of an additional foreign source is, to put it mildly, unnecessary. Once the Greek lyre had acquired nine strings, it was hardly evitable that a continuous Greek diatonic tuning would match a Babylonian one, just because the Near Eastern system came with a complete set of possible tunings.

The only chance to provide evidence for a more intimate connection between both musical traditions lies in the possible proof that a similar modality was connected with the common tuning. Such an investigation must be done in three steps: firstly, we have to consider if there are modal relations that are suggested by the tuning itself, and can therefore not be taken as an argument for a historical connection, even if found in both traditions. Secondly, we have to examine available information about the modal structure of the given tuning in both cultures: how is the tonal raw material put to musical use? Finally we can compare the modal conventions, and assess the probability of their mutual dependence or independence.

Apart from the basic, but perhaps not otherwise meaningful, boundary notes, the prima facie characteristics of any nine-stringed diatonic tuning are defined mainly by two factors, which go hand in hand:

1. At a certain position we find the discordant tritone instead of a fourth or fifth.
2. The two outermost strings at each end have their octave counterpart at the other end.

The first factor is certainly crucial both for Near Eastern and Greek music. Near Eastern tunings are built on pure fifths and fourths in the very first place, just as the Greek system with its tetrachords is. Moreover the 'unclear' tritone plays a central role in the retuning text. Even if the tritone was used in accompaniment[54], it can only have functioned as a transitional discord; it was certainly of no primary modal importance.

The second characteristic must have been of greatest influence in 'dichordal' music. All those dichords that include, in their 'canonical' form, one of the two highest strings, could be realized as well with the equivalent lower string, or with both of them. Thus the corresponding notes were not just present twice. All 'dichords' in which they take part could be played not with two, but with three strings. In this way especially the primary dichords, taking the form of an octave

[54] Gaudentios, *Harm.* 8, p.338 Jan; cf. West 1992, 206.

divided into a fourth and a fifth, acquired a richness of sound that is very likely to have resulted in modal prominence. Accordingly we should not be surprised to find one or more of the following combinations playing an important role in 'Dorian'/*nīd qabli* tuning:

d — *fifth* — a — *fourth* — d'
d — *fourth* — g — *fifth* — d'
e — *fifth* — b — *fourth* — e'
e — *fourth* — a — *fifth* — e'

If all of these are actually employed, their combination can produce another modal effect. Only the central note of the tuning, a = LA, appears in such a maximally concordant relationship with both doubled notes, and might hence gain modal prominence of its own. So we arrive at a set of plausible structural relations for the given tuning, which can be expected to occur independently in different traditions.

Let us now consider what we can know about modality in Greek music. There is of course the celebrated functional primacy of the *mésē*, 'middle' note, which maintained its central position from the time of the seven-stringed lyre on up to the fully evolved 'Perfect system', which comprises two octaves[55]. All other notes, we are told, obtain their function only from their relation to *mésē*[56]. Good melodies re-establish their tonality by constantly reverting to this note[57]. As we have seen, such a prominence of the central string could be predicted from our tuning, though in Greece it is most probably considerably older than the nine-stringed lyre and related to the basic tuning structure. For if we can trust our sources, the most influential tuning was already based on the framework e–a–b–e' in the seventh century[58]. These were the 'fixed' notes, common to all genera and tuning shades. The modal function of e = MI as the standard final note is exemplified in the majority of all extant closings: in the archaizing initial sections of both Delphic Paeans (128 BC) and in the fifths and sixths part of the Second Delphic Paean as well as in three of Mesomedes' hymns (2nd cent. AD)[59]. The fifth above it, b = SI, is prominent in the opening of the Invocation to the Muse, which emphasizes the

[55] For the structure of the Perfect System, cf. e.g. West 1992, 221–223; for its evolution, see Hagel 2005.

[56] Cf. Kleoneides, *Harm.* 11, p.202.3–5 Jan; Ps.-Arist. *Prob.* 19.20, 19.33; cf. also Dio Chrysostom, Or. 68.7, 2.234 Dindorf.

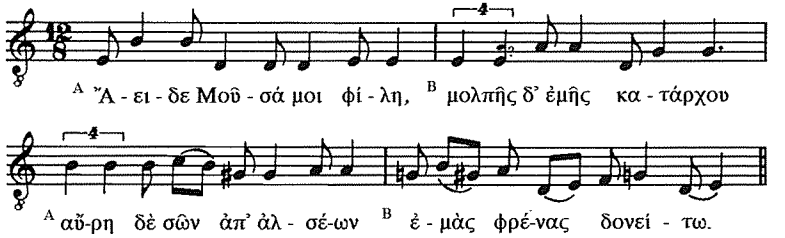
[57] Ps.-Arist. *Prob.* 19.20.

[58] Cf. note 49 above.

[59] DAGM 24. 25. 27. Cf. Winnington-Ingram 1936, 45. For an overview of initial and closing formulae cf. West 1992, 192–194.

empty structural framework. The high e'= MI is final note in the second and third parts of the Second Delphic Paean and plays an important role also in the First, especially in the opening of its third part.

In the Classical period, this framework was supplemented by the lower d = RE, providing the fifth below the focal note[60]. An exceptionally striking example for the interplay of all predicted fifth/fourth-relations as listed in the table above is found in the short Invocation of the Muse that is transmitted with the pieces by Mesomedes, but might be older[61]:



The first line proceeds from e–b to d and back to e, then from e–a through a–d down to d–g. The latter half of this movement has been convincingly compared to the procedure of tuning a lyre[62]. The second line reasserts the b, to land, after a modulating figure, on a. Another modulation is terminated by the fifth a–d, which leads over to d–g again. This interval occurs first as the boundaries of a continuous melodic movement, then explicitly in a downwards jump, only to lead back to final e again (probably to be accompanied with an e–a dichord).

In the context of the same modal structure, the higher d'= RE can also play an important role. It does so for instance in the Delphic Hymns. There, however, it is by no means the counterpart of the 'same' note an octave lower. Instead it is obviously used to invoke 'Phrygian' instead of 'Dorian' flavouring, and so it can foreshadow modulation[63]. It must be significant that the Greeks, although attributing the octave an especially unifying role among the intervals, did not treat notes an octave apart as remotely as exchangeable in function, as they are in the instrument-centred Babylonian system. The note names, for instance, did not convey any information about octave relationship.

Another, quite different, possibility of structuring the tonal space is not documented before the Roman period. It focuses on g = SOL, with d and d'= RE as secondary focus and possible final. We find this system in the famous Seikilos

[60] Cf. note 52 above.

[61] Cf. West 1992, 280; DAGM, 112. For the following transcription cf. Hagel 2000, 132, with a detailed interpretation 107–112.

[62] West 1992, 303.

[63] Hagel 2000, 39–43. 94–99.

song, in Mesomedes' Hymn to Nemesis, and probably still in the late Trinitarian hymn[64]. Some emphasis is put on what we would analyse as a G-major chord, SOL–SI–RE. We must wonder whether this three-note structure was reflected in fine tuning. If so, b = SI was tuned a pure major third above g = SOL, and accordingly a pure minor third below d' = RE, the sum of both thirds being the usual perfect fifth between g = SOL and d' = RE. If we notate those pure intervals as ratios of pitches, the presumed tuning would include the following relations:

g 10:9 a 9:8 b ? c ? d 10:9 e

Indeed one of the tunings described by Ptolemy in the second century AD matches our construction: it is his 'tense diatonic', the tetrachords of which are given as 16:15 – 9:8 – 10:9[65]. The corresponding 'Dorian' octave species reads as follows[66]:

$$e\,\frac{16}{15}\,f \quad 9:8 \quad g \quad 10:9 \quad a \quad 9:8 \quad b\,\frac{16}{15}\,c \quad 9:8 \quad d \quad 10:9 \quad e$$

Ptolemy makes it perfectly clear that in his opinion the mathematical relations describe exactly what is required by contemporary musical practice. If one constructs his ratios on an experimental instrument, he says,

> not even those most experienced in music would want to shift the tuning-bridges by the slightest amount[67].

It will be noticed, however, that such a tuning with a small whole tone (10:9) as the highest interval of the tetrachord is not documented before Ptolemy. Only about a century earlier, Didymos makes use of both kinds of whole tone, but he arranges them differently, within a tetrachord of interval sizes increasing with ascending pitch: 16:15 – 10:9 – 9:8. This kind of tuning is quoted by Ptolemy, but not incorporated into his own list of diatonic shades. Is it by chance that the musical fragments that display the new 'g-mode' were composed after Didymos,

[64] DAGM 23. 28. 59. Cf. Winnington-Ingram 1936, 45.

[65] Ptolemy, *Harm.* 2.14, p.74.1–2 Düring; cf. West 1992, 170–172. 239–240.

[66] One might object that in his account of lyre tunings Ptolemy does not mention any one consisting entirely of tense diatonic tetrachords; to the contrary, he says the musicians tune 'Pythagorean' intonation when singing tense diatonic. Yet in *Harm.* 1.15, p. 37.5–11 Düring, clearly pure eight-string tunings of each type are subjected to the judgment of the musical ear: ...ἐξέσται πάλιν κατανοεῖν ἀπὸ τοῦ διὰ πασῶν περιέχοντος ὀκταχόρδου κανόνος ... ταῖς γὰρ γινομέναις τῶν παρατιθεμένων κανονίων κατατομαῖς ἀκολούθως τοῖς ἐφ' ἑκάστου γένους λόγοις συναποκαθισταμένων τῶν ὑπαγομένων μαγαδίων, οὕτως ἔσται τὸ διὰ πασῶν ἡρμοσμένον...

[67] Ptolemy, *Harm.* 1.15, p. 37.5–12 Düring.

but – with the exception of the Christian hymn – before Ptolemy's time? Was he the first to account for a new musical style, a style, which has left the traces of its modal re-orientation in some of the extant melodies, but came within the scope of Ptolemy's interest only insofar it implied a slightly different shade of tuning?

We do not know whether this second, and obviously not 'traditionally Greek', modality was ever performed on a nine-stringed lyre with basic 'Dorian'/*nīd qabli* tuning. No doubt the final d found in the Seikilos song coincides well with the lowest d = RE of the tuning; and the overall pitch ranges of the relevant pieces provide no strong counter-argument. Neither the d–d' range of the Seikilos song, nor the c–d' range of the Hymn to Nemesis would per se require a different tuning (though one starting from low c = DO and finishing with high d' = RE must seem more plausible for the Hymn). Moreover, the relationship between the different keys in which the pieces are notated and the instrument tuning still remains unclear. But although we cannot exclude the 'g-mode' as a possible candidate for putting the 'Dorian'/*nīd qabli* tuning to melodic use, its seemingly late appearance alone is ground enough for not accepting it as evidence for Classical Greek 'Dorian' modality.

We can now turn to the question of Near Eastern modality, where our sources are naturally scarce. The texts tell us only the basic tunings as obtained by alternating fifths and fourths; and though the existence of a practice of fine-tuning has been suspected, there is no hint as to how it was achieved. Under these circumstances we are forced to extract all information from the small corpus of extant written music. And we must begin with the caveat that our results might reflect not more than one specific modal variety that was in use in a small region at a certain time. Even so, the traditional nature of the tuning system in general, and the fact that the Ras Šamra musicians found that this system was, at least by and large, adequate for writing down their music, give us some hope that the canonical seven tunings might well have incorporated some specific associations of modality and fine tuning.

Our research must be based on the simple question: which dichords do we find employed most frequently? Less simple is the problem of how to perform the counting. Nearly every dichord is in principle accompanied by a number. However, not all of the numbers are extant, because quite often a discernible dichord name is broken off at the right end. Numbers whose corresponding dichord is broken off at the left end are of course useless for our purpose. Should we count each dichord only according to its occurrence? Or is it better to take the numbers into consideration? For they are likely to express either repetition or duration, both of which must have added prominence to a dichord, while modally less important dichords will have been played more often only in passing. Without the numbers we are on the safe side, and we have a larger sample at our disposition. Inclusion of the number might increase our chance to get statistically valid results, at the cost of a greater amount of interpretation entering the evaluation at

the very start. So a first consideration suggests using the numbers only if no valid results are available otherwise.

A closer look at the nature of the numbers will confirm this approach. Only the numbers from 1 to 5 are found, plus an occasional 10. Their distribution is displayed in Diagram 1, where the rapid decrease of occurrence with increasing value is easily recognized[68].

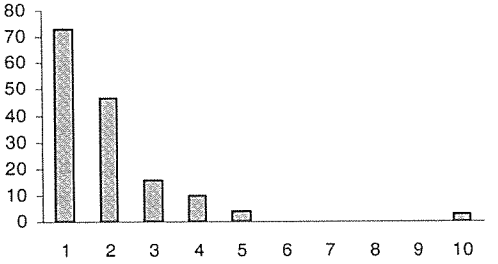


Diagram 1. Occurrences of numbers in the Hurrian hymns.

The presence of 10 after the wide gap from 6 to 9 raises suspicion[69]. It has been proposed to take this value not as an explicit number, especially since 10 is, like 1 and unlike the intervening numbers, written by an uncomposed cuneiform sign, 𒌋. This suggestion can be proven mathematically. Diagram 2 shows that the occurrence of the first five numbers approximates an exponential function very closely ($R^2 = 0.98$). There is no other simple function that describes the data remotely as well, so we must accept that any interpretation of the musical meaning of the numbers must account for an exponential decrease. The zero values of 6 to 9 could not enter into the calculation of the formula, but they fit into the picture quite well[70].

[68] The basis for the following evaluations are the texts as published by Laroche 1955 and 1968 – whether transcribed or not – and emended by Dietrich – Loretz 1975. Restorations have been applied cautiously (e.g. I have not included the readings considered by Güterbock 1970, 48 with note 4, though confirmed by Laroche 1973, 124–125, because they are already governed by the search for new correlations and not paralleled by completely preserved readings). The counting was done electronically.

[69] Cf. Wulstan 1971, 378; West 1994, 177 note 42.

[70] A χ^2-goodness-of-fit test with an optimized function of about $f(x)=1.11e^{-0.75x}$ (which is still noticeably close to the formula obtained only for the first 5 numbers) gives the following results for the numbers 1 to 9: $\chi^2=4.88$ with $k-m-1=2$ degrees of freedom ($m=2$: two parameters of the exponential function have been estimated from the data), so $p=0.087$; we cannot reject the null hypothesis of exponential decrease at the 5% level. Although we would expect almost two instances of 6 and one of 7, their absence cannot, from a mathematical point of view, be assumed to be more than accidental (for 6, $p=0.150$; for 7, $p=0.409$).

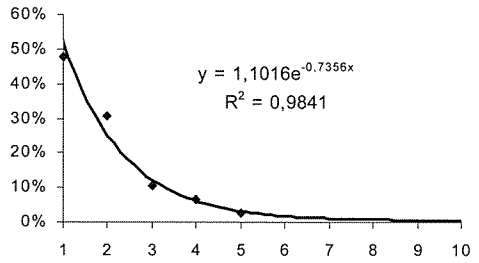


Diagram 2. Distribution of the occurrences of the numbers 1–5 as exponential function.

On the other hand, the occurrences of 10, though only three in number, cannot possibly be reconciled with the picture that emerges from the rest. No meaningful function that fits the (obviously exponential) decrease of occurrences of 1 to 5 and the complete absence of 6 to 9 can incorporate the three instances of 10. On the basis of the exponential curve, we would expect to find only one instance of the number 10 if our corpus of Hurrian notation were a hundred times larger. The chance for three instances within our sample would be not more than three out of a million.

So we must conclude that the 10's in the notation are not numbers in the same sense as those from 1 to 5. If these indicate durations, a 10 would likely denote a duration of extended, but not specifically defined length, an approximate equivalent of our fermata. If they designate repetition counts, the most straightforward interpretation of a 10 is analogous to a reciting note (*tuba*), to be repeated as often as needed.

Furthermore, the exponential distribution of the numbers can be taken as an argument against the duration hypothesis. Duration values of at least five types make sense only within a quantitative rhythmical scheme, which would be based on repetitive patterns of any kind[71]. But such patterns would bring about a hierarchical structure of dependence between different values. Especially a 5 can hardly be regarded as representing a primary rhythmical element; it must stand for a synthesis of minor units. The relative occurrences of all values would then be governed by the primary rhythmical structure; consequently it is hard to see how they should be distributed exponentially. This is not to say that the simple repeat count hypothesis can be proven on that ground. Other explanations are possible,

[71] Cf. Duchesne-Guillemin 1975, 375.

and perhaps even more likely in the face of the detected distribution[72]. The notated dichords might, for example, represent only the lyre strums on rhythmically prominent points, with intervening improvised plucking, roughly analogous to guitar chords. In this case the numbers may have counted downbeats, or even 'bars'. The assumption of such a rudimental notation, though a priori not unlikely, would of course deprive us of any hope to reconstruct the melody, especially as the rhythmization of the text (if there is any) remains in the dark.

In any case it is now clear that we cannot take a 10 as a numerical value; so we could base our counting on the numbers only if we discard the respective dichords entirely. But it seems unwise not to take those into account which seem to have some special prominence[73]. Thus, Table 2 is ordered according to occurrences of the dichords' names, the sum of the numbers being used only where two dichords are found the same number of times. The accompanying graphics show that on this basis the decrease follows a straight line in good approximation.

Dichord	Occurrences		Numbers
šēru	29	15.59%	29
rebūtu	29	15.59%	21
nīd qabli	22	11.83%	36
šalšatu	22	11.83%	35
serdû	20	10.75%	26
titur qablītu	14	7.53%	10
qablītu	13	6.99%	25
titur išartu	10	5.38%	14
kitmu	10	5.38%	10
embūbu	10	5.38%	8
isqu	6	3.23%	5
išartu	1	0.54%	10
nīš gabarî	0	0.00%	0
pītu	0	0.00%	0
Total	187		228

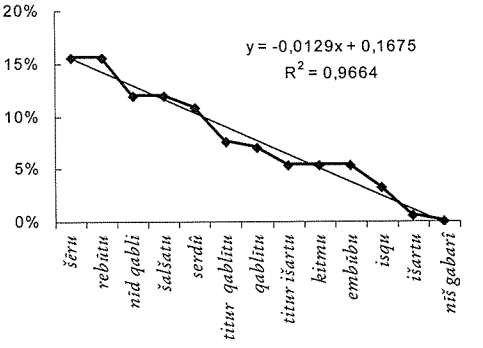


Table 2. Dichord occurrences in the Ras Šamra hymns.

[72] An evaluation of repeated notes (syllables sung on the same note) in the fragments of Ancient Greek music yields no comparable distribution, and can be described neither by an exponential nor by a power function: single repetitions are so much more frequent (84.33%). Only the decrease from three to eight consecutive identical notes is described by a power function in good approximation: $f(x)=2.32x^{-4.2}$; $R^2=0.985$; goodness-of-fit test: $\chi^2=2.36$ with one degree of freedom, $p=0.124$.

[73] The dichord *išartu*, for instance, is named only twice, once with the number 10, and once with its number lost. Consequently it would not even appear in a number-based counting.

Two dichords are entirely absent from the extant corpus of Hurrian notation: *pītu* and *nīš gabarî*[74]. That no *pītu* was ever played is no wonder, as in *nīd qabli* tuning this dichord incorporates the dissonant tritone[75]. But *nīš gabarî* is nothing else than e–a = MI–LA, one of the most resonant dichords on the nine-stringed lyre, and the most important one in Classical Greek music. Hence we learn that the modality of the hymns is not fully determined by the basic relations of fifths and fourths which constitute the tuning, but establishes an independent sub-structure of its own. The complete disregard of the dominant Greek *mésē-hypátē* relation is a first proof that, as far as the Hurrian hymns are concerned, *nīd qabli* is quite unlike Dorian. A tuning that is seemingly identical at the surface is used rather differently in the two traditions.

Diagram 3 connects the above list with the corresponding note names. All dichords that constitute five percent or more of the material are printed; together they represent over ninety-five percent of our corpus. Primary dichords are represented as bold lines. But one immediately recognizes the dominance of secondary dichords, those of the third/sixth type: six out of the seven most frequently used ones are of that kind. After all, the eponymous dichord of the tuning, *nīd qabli*, holds the first place among the primary ones – and if we count by the accompanying numbers, it holds th first place of all[76]. A modally important role of the eponymous dichord is by no means obligatory, since we have seen that the names of the single tunings are derived from their structures in a wholly mechanical way. Still, the correspondence doubtlessly adds to the coherence of the Near Eastern system. Moreover, it boosts the chances that our results from the Ras Šamra hymns reflect more than just the idiosyncrasies of some particular Hurrian music style.

[74] Kilmer 1997, 477, misses *išartu* instead of *nīš gabarî* (by error? Or discarding the reading of h.6.5 by Dietrich – Loretz 1975, and, on the other hand, accepting that of RŠ 19164*n* and *o* by Güterbock 1970, 48 with note 4?). But cf. Kilmer 1971, 143.

[75] Kilmer 1974, 77 note 3. For the present we will take it for granted that all of the fragmentary hymns are in *nīd qabli* tuning, as are all where the mention of the tuning is extant. It is a priori likely that all tablets stem from a collection that was organized by tunings (West 1994, 170 note 22; cf. Kilmer 2002, 484–485); and the absence of *pītu* is a very strong argument in that direction. At any rate, possible single sherds of non-*nīd qabli* music cannot bias our statistics: they can obscure possible insights, not cause wrong ones.

[76] The concentration on hymn 6, where *nīd qabli* seems to play no prominent role, has obscured this fact (cf. e.g. Černý 1987, 51 note 15; Arndt-Jeamart 1992, 436). But although here *qablītu* (the other most resonant dichord on nine strings) seems dominant, *nīd qabli* asserts its underlying priority by being the target of the repeated triplet *šalšatu – rebūtu – nīd qabli*, which establishes a tonal structure of progression quite unlike the following oscillations (thrice *šēru – šalšatu*, thrice *kitmu – qablītu* connected by transitional *rebūtu*); on the significance of this sequence cf. below.

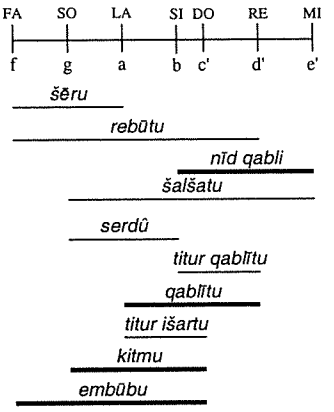


Diagram 3. Dichords representing 95% of the Ras Šamra notation.

There is enough evidence for pure thirds in Greek music[77] – some of which we have discussed –, within scales that are primarily (in practice) and explicitly (in theory) based on fourths and fifths. All the more plausible is the assumption of pure thirds in a musical style in which these intervals play the dominant role, covering about two thirds of the notated music (69.9%; or 61.1% if evaluated by numbers). But can pure thirds and sixths on one hand and pure fifths and fourths on the other be reconciled to form one consistent tuning? Only part of both types of interval can be pure at the same time. In principle there are three alternatives:

1. 'Pythagorean' intonation: all fifths and fourths, and no third are pure. This tuning is achieved most easily, but useless for music a substantial part of which consists of thirds.
2. Just intonation: neither all fifths nor all thirds are pure. Two conjunct pure thirds, one major and one minor, add up to a pure fifth. This is the perfect tuning for music based on chords and without extensive modulation.
3. Tempered tunings: Neither fifths and fourths nor thirds and sixths are pure. A compromise is sought in which both types of intervals sound acceptable. The extreme variant is equal temperament, which disposes of all modal characteristics that otherwise arise from respective intervals being of only roughly the same size.

As we have seen, only just intonation is plausible for the Hurrian hymns. 'Pythagorean' tuning is the worst alternative, taking into account the prominence of secondary intervals. Temperament does not make much sense in a musical style in

[77] Cf. Franklin 2005; pure thirds are attested in mathematical expressions of tuning since Archytas. Testing a resonant tuning by non-resonant ditonic thirds (as envisaged by West 1994, 165, and Gurney – West 1998, 226) is hardly of any use (cf. Crocker 1997, 198), even if the musician is accustomed to how they should sound: even Aristoxenos, the prime advocate of ditonic tuning, when it comes to establishing the ditone interval calls for "taking it through consonance", that is, constructing it by alternating fifths and fourths (Λῆψις διὰ συμφωνίας *Harm.* 2.55, p.68.15–69.5 da Rios).

which several intervals are only occasionally employed, or avoided entirely, and which does not use extensive modulation. If we are able to show that the hypothesis of just tuning is not inconsistent with the specific choice of intervals that is made in the hymns we must adopt it as the most likely interpretation.

And indeed, six out of the seven most frequent dichords do combine into three triads. The most important primary dichord, *nīd qabli*, corresponds to two secondary ones, *šalšatu* and *serdû*. Their combination builds a structure that we would interpret as an e-minor chord: g–b–e' = MI–SOL–SI. Similarly *šēru* and *rebūtu* correspond to *qablītu*, which we read as d-minor: f–a–d' = RE–FA–LA. This is not to say that the quasi-chordal construction of the observed arrangements played a part in the musical perception of the ancient hearer (quite the contrary, as we shall see). Still the mathematical laws of intervallic relations imposed these structures on the tuning: it is the only way to get a reasonable number of both types of dichords pure.

The two quasi-chordal triads are self-contained structures and provide no information about their tuning relative to each other. This information is conveyed by the last remaining of the seven most frequent dichords, as displayed in Diagram 4: *titur qablītu* functions as the bridge between *qablītu* and *nīd qabli*. This basic structure of two triads connected by a bridge interval defines six of the seven notes of the octave, and it accounts for eighty percent of the notation. Furthermore *titur qablītu* and *serdû* add up to the infrequent *išartu*, which is therefore also pure. Although this dichord is found only once, it is accompanied by the number 10 in hymn 6, where it seems to occupy a prominent position on other grounds, too[78]. *Nīš gabarî*, on the other hand, whose absence occurred to us as the most striking aspect of the evidence, is already marked out as impure.

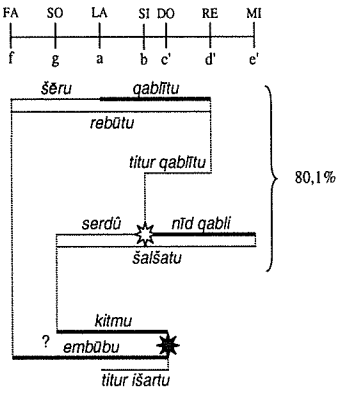


Diagram 4. The triadic tuning of the Ras Šamra hymns.

[78] It stands immediately before the poorly understood remark *uš-ta-ma-a-ri*, which has been interpreted as indicating the end of an instrumental prelude (most recently Krispijn 2002, 479; cf. also Thiel 1977, 132–133).

Only one tone is left undefined: c'=DO, which is by far the least used of all. Its exact pitch depends on the choice between the two dichords that share the next place in the list of frequencies. Either the c'=DO is tuned as a pure *kitmu* fourth above g=SOL, or as a pure *embūbu* fifth above f=FA. This decision will determine also the status of the remaining dichords *titur išartu* and *isqu*: the implications are listed in Table 3 under the headings 'pure *embūbu*' and 'pure *kitmu*'. As regards the corpus of notation, both possibilities yield almost identical results: with a pure *embūbu* 91.4% of the notated dichords are pure, which is only slightly better than the 89.3% of a pure *kitmu*. Is it significant in this context that in the dichord list *nīd qabli* is paired with the secondary dichord *isqu*, which defines exactly the note in question, starting from the second string of *nīd qabli*? If so, does it mean that *isqu* shall be tuned to a perfect third, which results in the 'pure *kitmu*' variant?

Dichord	pure *embūbu*	pure *kitmu*	maximal just tuning
šēru	✓		✓
rebūtu	✓		☹
nīd qabli	✓		✓
šalšatu	✓		✓
serdû	✓		✓
titur qablītu	✓		✓
qablītu	✓		☹
titur išartu	✓	☹	✓
kitmu	☹	✓	✓
embūbu	✓	☹	✓
isqu	☹	✓	✓
išartu	✓		✓
nīš gabarî	☹		✓
Total pure	91.4%	89.3%	77.4%

Table 3. Pure dichords in possible *nīd qabli* tunings.

On the other hand, if *nīš gabarî* is avoided altogether because of its dissonant character, which is a direct result of the perfect tuning of the most important relations, why then do we find instances of other dichords that are equally dissonant (whether these are actually *kitmu* and *isqu* or *embūbu* and *titur išartu*)? It does not seem very likely that modal characteristics should be responsible for this phenomenon: considering that all other dichords were used at least sometimes, a few instances of *nīš gabarî* should not have caused much irritation. Yet its absence is statistically significant, if compared with the other possibly dissonant dichords[79].

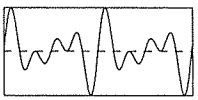
[79] Against the less frequent pair *isqu* and *kitmu*, p=0.0045. Even against only the six instances of the least frequent *isqu* alone, p=0.0486 (if RŠ 19164*n* and *o* actually contain instances of *nīš gabarî*, against *isqu* and *kitmu* p=0.059).

Perhaps the tone c'=DO was actually tuned to a compromise between the two possibilities, so that none of the four intervals was perfect, but all of them could be used at least from time to time without causing too much irritation: each one would be about the twentieth part of a tone off. This would mean a mixed tuning, which combines perfect intonation of the modally prominent intervals with maximum availability of the less important ones. Only *nīš gabarî*, which could not be incorporated into such a structure because it conflicts with the basic triads, was disregarded entirely in musical practice.

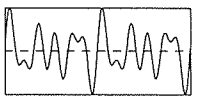
It must be added that the two possible 'just' tunings that emerge from the evidence are, in a certain sense, not optimal. While both of them incorporate four perfect fifths and six perfect thirds, in a heptatonic diatonic scale it is even possible to reconcile five perfect fifths with six perfect thirds: see Table 3 under the heading 'maximal just tuning'. In this 'optimal' tuning there is, apart from the necessarily dissonant tritone, only one impure interval of each category. Interestingly this configuration is identical with Ptolemy's 'tense diatonic', which we have surveyed above as testifying to a musical evolution in the Roman Imperial period. But here the dissonant fifth inevitably comes to lie between d=RE and a=LA, *qablītu*, which otherwise represents one of the two most resonant dichords in the nine-stringed tuning, as it involves one of the doubled notes and the fifth above[80]. So it is no wonder that the mathematically optimized structure was adopted neither for Near Eastern fine tuning nor for the Classical Greek lyre. If played in this tuning, almost a quarter of the dichords forming the notation of the Hurrian hymns would sound dissonant.

Now that we have established the fine tuning of the Hurrian hymns with some certainty, a word about the tuning procedure will be in order. The musician will first have to establish a rough 'Pythagorean' tuning by alternating fourths and fifths, starting from *nīd qabli* with the fourth string (b=SI, indicated by the white star in Diagram 4). This is important firstly because thus the musician need not distinguish the different types of thirds and sixths by ear, nor remember the respective positions of major and minor ones in the tuning[81]. Secondly, in this first run all the strings will also acquire a tension that comes very close to its final value. Since any considerable pitch adjustment will slightly change the geometry of the instrument and hence distort the formerly tuned intervals, a second run is

[80] This structure of a fourth above a fifth corresponds directly to the first three partials; therefore its sound-waves blend optimally and it is more concordant than the opposite arrangement; for a simple illustration of this fact cf. the following graphs (basic frequencies without higher partials):



nīd qabli / qablītu



nīš gabarî / išartu

[81] Cf. Smith – Kilmer 2000, 133 Table 1.

inevitable in tuning the lyre or the angular harp. So the overall amount of work is not increased by a non-Pythagorean fine-tuning. Once the rough tuning stands, it will be best to start once more from *nīd qabli*. With *serdû*, taken again from the initial fourth string (a third is much easier tuned than a sixth) the first triad is completed; then, still from the same fourth string, *titur qablītu* establishes a starting point for the second triad, leading over to *qablītu* and *šēru*. For the last string there are, as we have seen, several possibilities: to establish it by *kitmu* or by *embūbu*; or by *isqu*, the dichord paired with *nīd qabli* in the 'mathematical text'; or perhaps to find an acceptable compromise by tempering. The ideally resulting intervallic relations are displayed in the following table, where the first line of the figures indicates the pitch relative to the central string; the second line the intervals between adjacent strings; and the last line the same intervals expressed in cents[82]:

RE		MI	FA		SOL		LA		SI	DO		RE		MI
d		e	f		g		a		b	c'		d'		e'
2/3		20/27	4/5		8/9		1/1		10/9	(?)		4/3		40/27
	9:10		25:27	9:10		8:9		9:10					9:10	
	182		133	182		204		182	112–133		182–204		182	cents

Diagram 5. The probable tuning of the Hurrian hymns on the nine-stringed lyre.

The frequency of occurrence of the dichords was the favoured criterion for determining their modal relations as reflected in the tuning. Another possible way to establish a hierarchy is to use the accompanying numbers, not by simply adding them, but by finding their mean values: whatever the numbers designate, it is likely that modally important dichords will tend to get more of it at a single time. Due to the small sample size the results will not be very reliable as regards an exact order, but at least an overall impression can be achieved. The figures are given in Diagram 6.

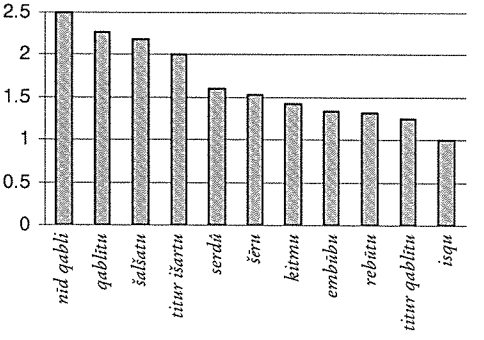


Diagram 6. Average numbers in the Hurrian hymns.

[82] 100 cents are equivalent to one semitone of equal temperament.

The most important result of this arrangement is that *nīd qabli* now holds the first place, followed by another primary dichord, *qablītu*. These are not only also the most frequent primary dichords, but at the same time the most resonant ones on the nine-stringed lyre[83]. The most straightforward interpretation of these facts is that these structures of fifths and fourths functioned as harmonic centres, even though most of the (in-between) musical material of the hymns is constructed of thirds and sixths. Once more Near Eastern music reveals itself as governed by the principle of resonance.

A comparison between Table 3 and Diagram 6 shows that the hierarchy established in the latter is in perfect concord with the tuning that emerges from the numbers of occurrences: had we started from the series of Diagram 6, we would have arrived at exactly the same conclusions regarding the tuning.

A modal hierarchy of intervallic relations is one thing; their interplay in music remains yet to be investigated. But is it possible at all to obtain any insights from a sample as small as ours? As we shall see, it is, as long as we insist on mathematical proof for each piece of evidence. So for instance we must not rely on absolute values, but must always compare them to carefully calculated expectations. If two dichords are frequent per se, we need not be surprised if we find instances of direct successions from one to the other. Only if such successions are even more frequent than we would expect on the basis of the other evidence may we ascribe modal significance to such a configuration.

The most secure way to obtain values of expectation will start not from mere dichord frequencies, but from observed dichord frequencies as first or second dichord of an extant pairing[84]. The difference will not be great, but only so we can assure that the calculations also hold for typical initial or final dichords – especially if written line ends sometimes corresponded to structural breaks in the music (only very seldom do we have the end of a line preserved together with the start of the next one). To obtain the expectation for a given succession of dichords it will then almost suffice to determine the proportion of the first dichord in all first dichords of extant successions, as well as the proportion of the second dichord in all second ones, and to multiply these two values. The calculation becomes just a little more complex because there are no successions of equal dichords in the Hurrian notation, so we must avoid attributing expectations greater than zero to them (the total of expectations must always be 100%). If we write

[83] Cf. note 80 above.

[84] For example in a succession of three dichords *a*–*b*–*c*, there are two such pairs, *a*–*b* and *b*–*c*. This small sample yields the following distribution:

	a	*b*	*c*
as first member of a pair	1	1	0
as second member of a pair	0	1	1

Only certain readings or practically certain restorations (i.e. parts of words that match only one term found elsewhere in the hymns) enter the following calculations.

the number of occurrences of dichord i as the first member of a successive pair as ${}_1x_i$, and as the second member as ${}_2x_i$, while $n_d = 14$ is the number of different dichords, we obtain the corrected expectations for the immediate succession of two dichords a and b as

$$E(a \rightarrow b) = \frac{{}_1x_a \; {}_2x_b}{\sum_{i=1}^{n_d} \sum_{j=1}^{n_d, i \neq j} {}_1x_i \; {}_2x_j}$$

This formula gives percentages; to get the actually expected number of occurrences it must be multiplied by the number of observed pairs. From this expectation it is easy to calculate the 'significance' of the data. The dichords *qablītu* and *kitmu* for instance are both not among the most frequent ones. Accordingly the calculated expectation for a succession *kitmu–qablītu* is only 0.22%. In other words, if the succession of dichords were guided by pure chance (but still on the basis of their relative frequencies as observed), we would expect only one instance of *kitmu–qablītu* in over 450 pairs. But within our corpus, which includes only 79 pairs, we find no less than three instances. Such a result is extremely improbable under the assumption of a 'pure chance' distribution; it could be expected only once in a dozen hundred similar samples. Accordingly we must take it as proven that the progression from *kitmu* to *qablītu* was deliberately sought. On the other hand, we cannot at the same time assume with the same confidence that this succession was part of the standard *nīd qabli* modality of the hymns: all instances stem from the same context, namely the last line of hymn 6. Perhaps the threefold repetition of the same sequence there was some unusual effect. Still this is the final part of the notation, a place where we would rather not expect atypical turns, not even if it was only the end of the strophe and a refrain was to follow, as has been proposed[85].

Table 4 lists all pairings whose frequency is significant at the 10%-level[86]. Nevertheless, most of them fall into much more reliable levels, as a look into the respective row will show. As regards the rest, we will have to verify their status by other means. The table comprises all successions that occur more than three times, and 72% of the whole corpus.

A glance at the transcription into modern note names makes it immediately obvious that the dichordal progression of Hurrian music was conjunct to a very high degree. In these most favoured successions steps of only one scalar degree are most frequent; often one note stays the same; and if there is a movement of a third at one end, the other end displays conjunct motion.

[85] Güterbock and Kilmer in Kilmer 1974, 75–77.

[86] The order of the note names follows the 'mathematical text'.

For further investigation we have to classify the progressions. Since we do not know beforehand the number of strings of the instrument for which the hymns are written, we have to build our categories by normalizing dichords to intervals: each succession is taken within the smallest necessary interval. This procedure ensures that we are not mistaken by the differences imposed on similar dichords by their heptatonic arrangement in the 'mathematical text': all primary and all secondary intervals are treated as equal, regardless whether they appear as fourths or fifths, thirds or sixths in their canonical form. The totals of the resulting categories, indicated by numbers in Table 4, can then be subjected to statistical tests that yield much better significances than the individual values.
Surprisingly there is not very much variation in the types of melodic movement. With few exceptions, the dichord successions fall into one of only three major categories.

dichord succession		category	direction of movement	occurrences	expected occurrences	level of significance
kitmu–qablītu	gc–ad	*4a*	↗	3	0.18	0.00076
serdû–šēru	bg–fa	*1*	↘	6	1.23	0.00148
titur išartu–serdû	ca–bg	*1*	↘	5	0.96	0.00289
titur qablītu–titur išartu	db–ca	*1*	↘	2	0.09	0.00359
rebūtu–nīd qabli	df–be	*2*		4	0.70	0.00550
isqu–titur qablītu	ec–db	*1*	↘	2	0.15	0.00959
šalšatu–rebūtu	eg–df	*1*	↘	7	2.46	0.01153
šēru–šalšatu	fa–eg	*1*	↘	6	2.09	0.01842
šēru–serdû	fa–bg	*1a*	↗	6	2.09	0.01842
nīd qabli–titur qablītu	be–db	*5*	↘	3	0.66	0.02856
embūbu–rebūtu	cf–df	*3*	↘	3	0.82	0.04919
šalšatu–embūbu	eg–cf	*2*		3	0.88	0.05809
nīd qabli–isqu	be–ec	*3*	↗	2	0.39	0.05971
qablītu–kitmu	ad–gc	*4b*	↘	2	0.44	0.07171

Table 4. Frequent dichord successions in the Hurrian hymns ($p < 0.1$).

1. The first one is that of the descending thirds, which contribute so much to the character of the music of hymn 6 (if played in dichords). This is clearly the dominant kind of motion; it accounts for more than one third of the extant

notation (36.7%)[87]. Printed as an abstract section of tablature with one line per string and low notes at the bottom it takes the form of  . Sequences of descending thirds are so characteristic that some of the less frequent intervals seem to be admitted especially to enable such continuous movements.

Naturally in a heptatonic scale there are seven possible 'descending thirds' combinations, one starting from each step of the scale. But only six of them are actually found in the hymns. Missing is the succession *rebūtu–isqu*, which corresponds to df–ec in modern notation. Of all combinations this is the only one that cannot be played as a succession of two conjunct thirds on the nine-stringed standard instrument of music theory. With its two notes that are doubled at the octave this instrument encompasses all seven possible thirds, but allows for only six conjunct progressions between them: between the two extreme thirds there is a step of a seventh instead of a second. Is it by chance that of all dichord successions that can correspond to descending thirds it is exactly this one which is missing from the hymns[88]? If not, we have encountered another striking coincidence between 'Babylonian' theory and Hurrian practice: the music of the hymns appears still as oriented toward, if not performed on, a nine-stringed instrument.

Does it follow from the preference for descending thirds, that all of these were played only as thirds, that is, without doubling one string at the octave where possible? I do not think so, because the characteristic impression of the movement is preserved nevertheless – at least if the doubling string is one of the low ones.

While descending thirds are so obviously favoured, the same cannot be said of ascending ones[89]. Though the hymns contain ten instances of these, only one kind appears significantly often (*1a*).

2. The second category can be printed as  , a third followed by a fourth. Apart from the pairs listed in the table, one instance of each *šēru–išartu* and *titur qablītu–kitmu* also belong here[90]. At first glance the movement again seems descending. But this is due only to our normalization conventions. On the nine-stringed instrument, only two out of nine instances could indeed be played in

[87] The expectations of all falling thirds taken together amount to only about the fourth part of the actual values, 7.09. Accordingly, $p=4\cdot10^{-11}$.

[88] The sample is not big enough for a conclusive statistical proof. If we take the overall frequency of falling thirds as a starting point and correct the expectations on that ground, we would expect 2.03 instances of the missing *erbūtu–išartu* succession. This gives about a one out of seven probability for the observed absence ($p=0.130$).

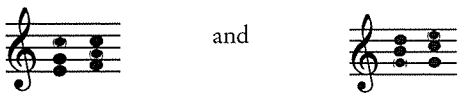
[89] From the overall occurrences of the respective dichords, we would expect to find 6.97 instances of ascending thirds: $p=0.106$.

[90] Taken together, the expectations of this category amount to 2.09, as opposed to 9 actual instances: $p=0.00033$.

that way; the most prominent succession *rebūtu–nīd qabli* would even require eleven strings. So it is clearly more appropriate to interpret this type as  , a third followed by a fifth. Obviously this was the canonical way to arrive at a primary dichord, and probably to mark it out as the (momentary) tonic centre. Both notes of the third function as leading notes to the bottom note of the fifth. Especially *nīd qabli*, for which we have inferred modal importance, is always reached in this way in the hymns (where its preceding dichord can be determined). Furthermore the secondary dichord is always qualified by the number 1, with one exception (a 2 for *titur qablītu* in hymn 13), which reinforces the impression of its transitory function. In most cases the structural breaks of the music elude us. But in two cases such progressions stand at the end of the notation[91]; and in hymn 6 we find one before the remark *uš-ta-ma-a-ri*, where a break of some kind is very likely.

Where the lower note of the third lies a half-tone below the bottom note of the fifth, the parallel to the cadential progression from the dominant to the tonic in European music is striking. This is the case with

šalšatu–embūbu *titur qablītu–kitmu.*



In *rebūtu–nīd qabli*, on the other hand, the half-tone lies above the following tonic focal note. The d = RE as the other leading note to e = MI is reminiscent of ancient Greek melodies; but there the e = MI is modally connected with a = LA, not with the b = SI of *nīd qabli*.

3. A third category provides a transition from primary to secondary dichord, in a rising motion[92]. *Nīd qabli* is one of the attested starting points; and I suppose that this movement was especially useful at the outset of a musical phrase[93]. It can be printed schematically as  or  .

These three types of melodic/harmonic movement together describe more than half of the extant material (54.4 %). Of those that remain we have already mentioned the parallel movement between the primary dichords *kitmu* and *qablītu*, both ascending and descending (4a and b), all instances of which stem from

[91] In h.13: *titur qablītu–kitmu*; in h.14: *rebūtu–nīd qabli*. See, however, the reservations made in note 93 below; but, while the text of h.13 is entirely lost, h.14 does not seem repetitive.

[92] The total of expectations is 1.71, so the observed 5 instances are significant at the 5%-level: p=0.033.

[93] The sequence *embūbu–rebūtu*, on the other hand, stands at the end of the notation of h.8 and 28. Almost nothing of the lyrics of h.28 has survived. But the text of h.8 is among the extremely repetitive ones, so that it is quite likely that the music of a refrain was already notated above: so it is even possible that the 'notation-final' figure served as a rising motion announcing the start of the refrain.

the alternation in the last line of hymn 6. No other conjunct parallel primary dichords are attested: was there an objection against parallel fifths?

The last succession that is more or less significant (5) represents another possibility of advancing from the tonic *nīd qabli* to the realm of thirds and sixths, this time by descending motion, to *titur qablītu*. The progression was perhaps formulaic: all three instances seem to be followed by *titur išartu*[94]. A third option of such a transition led from *nīd qabli* over to *šēru*, with three attested instances.

Another striking aspect of the Hurrian pieces is the almost complete absence of progressions that would, in our perception, form chords. The quasi-chordal triads, which were so crucial for the structure of the tuning, are of no importance for the music itself. Of all possible combinations of thirds and fifths that are part of the same chord we find only four instances[95]. In this case, the avoidance is highly significant[96]. Also significant is the fact that all of the attested instances belong to the same triad, namely that of *qablītu*, *šēru* and *rebūtu*: d–f–a = RE–FA–LA[97]. These combinations are by no means favoured[98], but it is interesting that of all chord-building sequences only they are admitted. And not even all of them: the successions of thirds seem to be excluded, so that the primary *qablītu* is always present[99].

Although the uniformity of the material and the seeming formulaity of some of it allowed us to extract an unexpected amount of modal information from it[100], we must not forget that much of the nature of the notation remains unclear. What we were able to determine as favoured 'harmonies' and 'harmonic progressions' may apply at the level of single vocal notes connected with syllables (or even subsyllabic parts of melisms) or at the level of larger rhythmical units. Not only the rhythm and the tempo of the original performance, but also the relative speed of dichordal progression, of the change between basic harmonic configurations, remain unknown.

[94] H.6.7; 7.10; 21.6.

[95] There is, similarly, no instance of a succession of the two secondary intervals that add up to the tritone, *titur qablītu* and *rebūtu*.

[96] The total expectance for all combinations (without the tritonal ones) amount to 22.56, so $p=4.8\cdot10^{-8}$.

[97] There are six 'chords' in the diatonic scale (the seventh step being occupied by the tritone). Calculated from the respective expectances we would expect just 1.41 instances out of the observed 4 to fall within the *qablītu* family. The probability to find all 4 there by chance is only $p=0.015$.

[98] We expect 7.95 instances instead of 4 ones; still this need not indicate avoidance: $p=0.074$.

[99] This fact is significant at the 5%-level: $p=0.037$. If we take '*qablītu* with one of its constituent secondary dichords' as a category, its 4 occurrences match the expectation of 3.50 perfectly.

[100] If we concatenate the favoured harmonic progressions we might be able to deduce larger typical 'harmonic' movements, especially *nīd qabli – šēru – šalšatu – rebūtu – nīd qabli* and *nīd qabli – titur qablītu – titur išartu – serdu – šēru – šalšatu – rebūtu – nīd qabli*. The latter is indeed attested in full length in h.6.7–8.

It remains to add some words about two more specific problems of the Hurrian notation: the potential significance of dichord directionality, and the recurring qualifications accompanying some dichords.

We remember that the succession in which the two strings defining each dichord are named in the 'mathematical text' does not follow a simple uniform rule. Although we were able to understand the underlying system from just the list and the function of the primary dichords in the (rough) tuning process, it can be read as attributing to each dichord a specific 'first' and 'second' string. In the course of the attempts to interpret the notation as melodic, a striking observation has been made in this context: in a remarkably large number of cases, the 'second' strings of successive dichords are neighbouring strings[101]. This predilection for conjunct motion was interpreted as the melodic progression: the 'second' strings would then notate the melody, the 'first' ones some kind of "accessory notes". This interpretation is, of course, open to criticism[102]. It is, for instance, not entirely convincing that the "accessory" notes available for each melodic note should have been so limited: only half of the resonant combinations are provided for, and it is especially odd that a theoretical construction such as the 'mathematical text' is should have imposed such an essential restriction on musical practice. But even if the interpretation be rejected, the pattern remains; and it must be emphasized that any valid interpretation of the Hurrian notation must account for the preponderance of 'second'-string conjunct movement. For the significance of this phenomenon can be established beyond doubt, as the following considerations will show.

A first possible objection to the validity of the observation is that the unequal distribution of conjunct and non-conjunct movements between 'first' and 'second' strings results merely from the prominence of certain dichords, thus being a side effect of modality[103]. To examine this possible explanation we need only calculate expectation values that are based on the actual occurrences of dichords, quite similarly as we have done for dichord successions. The only difference is that now the expectations must be grouped according to the 'melodic steps' they include between 'first' and 'second' strings. Because of the exchangeability of notes one octave apart, every progression must again be normalized to the smallest interval. This is not only necessary but in this context justified insofar as we do not aim at absolute results, but only at a comparison between possible (espe-

[101] West 1994, 175–179.

[102] Cf. Crocker 1997, 201.

[103] The asymmetrical directionality of the secondary dichords per se does not produce a corresponding asymmetry in the set of the 182 possible dichord successions: 33.0% of both 'first' and 'second' string movements are conjunct. Even if we exclude the tritonal *pitu*, the differences are minute: the percentages amount to 32.0% and 34.6% respectively.

cially small) progressions. In Table 5 these are given with their direction as small intervals[104]; a movement of four steps is indeterminate in this respect. Deviations from the expected values are printed as percentages of these; bold values are significant at the 1%-level.

	'First' strings			'Second' strings		
	observed	expected	deviation	observed	expected	deviation
4	1.27%	4.46%	-71.61%	2.53%	5.32%	-52.43%
3↗	16.46%	15.26%	7.81%	**3.80%**	13.05%	-70.91%
2↗	8.86%	16.20%	-45.30%	**2.53%**	15.93%	-84.11%
1↗	13.92%	16.33%	-14.71%	21.52%	18.30%	17.57%
0	**0.00%**	6.65%	-100.00%	6.33%	8.56%	-26.05%
1↘	**34.18%**	15.82%	116.02%	**53.16%**	18.72%	184.06%
2↘	12.66%	15.61%	-18.89%	**5.06%**	14.17%	-64.26%
3↘	12.66%	9.67%	30.86%	5.06%	5.95%	-14.92%

Table 5. Progressions between 'first' and 'second' strings.

The table confirms that the most striking phenomenon is the preference for downwards motion between adjacent 'second' strings (1↘), at the expense of larger steps. Not as prevalent, but still highly significant, is the same type of movement between 'first' strings. Conjunct upwards motion between 'second' strings, on the other hand, is not per se conspicuous. Nevertheless, its preponderance over all the types of non-conjunct motion is large, even significantly large; so that the prima facie result is perhaps due only to the overshadowing presence of the respective downwards movement[105]. So the first results of our extensive evaluation seem to support a specific role of dichord directionality and especially the 'second' strings. At the same time they cast doubts on the hypothetical identification of their notes with the vocal melody: why then should an iteration of the 'first' string be avoided altogether? If this string supplies only "accessory notes", it is not easy to see why the same accessory note should not be allowed for successive vocal notes. The opposite interpretation seems to explain the data better. If the 'first' strings took the melody, there might have been felt no need to alter the 'accompaniment' until the melodic note changed. The 'accompaniment' note could

[104] The small differences between the figures printed here and those given by West 1994, 175–176, – e.g. my 74.7% instead of West's 70.5% of conjunct 'second' string motion – result partly from my rather cautious admission of not completely certain readings; some instances remain for which I am unable to reconcile West's figures with his list.

[105] All in all, there are 17 instances against an expectation of 14.46: $p=0.270$. Viewed only against conjunct steps, the expectation drops to 8.33, with $p=0.0014$.

sometimes stay the same[106]; and the numbers of the notation would suffice for indicating repeated melody notes. The increased tendency for conjunct motion in the 'second' string would then reflect the style of the accompaniment. Especially on strummed lyres where the fingers of the left hand must dampen all but two (or, with octave doubling, three) strings, this type of movement is easier to play, since it more often than not needs only the adjustment of one finger. Still it must be said that with that type of accompaniment one should also expect a larger amount of zero movement in the accompaniment. And after all, an interpretation of 'first' string notes as the 'melody' of the hymns confronts the same basic reservations as the 'second' string hypothesis: only a very limited subset of possible combinations is available.

Indeed, a closer view at the facts reveals that neither of the two interpretations can be upheld. The fairly high amount of conjunct motion in both strings will of course correspond to a certain preference for that kind of motion in the vocal line. What needs explanation is only the divergence between 'first' and 'second' string.

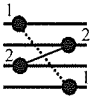
dichords	occ.		'first'	'second'	both
embūbu – rebūtu (3)	3	cf–df	1↗	(0)	
rebūtu – šalšatu (1a)	3	df–eg	1↗	1↗	1↗
kitmu – qablītu (4a)	3	gc–ad	1↗	1↗	1↗
šalšatu – šēru (1a)	2	eg–fa	1↗	1↗	1↗
serdû – šēru (1)	**6**	bg–fa	(3↘)	1↗	
nīd qabli – rebūtu	1	be–df	(2↗)	1↗	
embūbu – šalšatu	1	cf–eg	(2↗)	1↗	
titur qablītu – kitmu	1	db–gc	(3↗)	1↗	
		Total 1↗	11	17	8

Table 6. Dichord successions resulting in ascending conjunct motion in 'first' and 'second' strings.

Let us consider conjunct rising motion first, where we find 17 instances for the 'second' but only 11 for the 'first' string (see Table 6). There are eight instances of simple parallel movement, either in thirds/sixths or in fourths/fifths, which leads to the adjacent higher note in both strings. The remaining three instances for the 'first' string result from the progression from *embūbu* to *rebūtu*, which fall into our category *(3)*. There are also three further unsuspicious instances for the 'second' string. So far we find no difference at all between the two types of strings.

[106] The second string iterations match their expectations very well: there are 6.76 instances expected and 5 found ($p=0.32$).

The whole dominance of the 'second' string is, in this case, based on just one succession type, that from *serdû* to *šēru*. But this is nothing else than one of the descending thirds, which represent the most frequent category of all. How is it that we find this type of movement, which inserts itself so nicely into a descending category, in the context of rising motion? To blame is the mechanical application of the 'directionality' of the 'mathematical text'. Thanks to its break of symmetry this list assigns 'falling direction' to *šalšatu*, but 'rising direction' to *šēru*. Consequently the parallel descending movement, if interpreted by 'first' and 'second' strings, is artificially broken up into a rising second and a falling fourth:



Such an interpretation could only be accepted if the validity not only of our category of descending thirds were denied, but also of other ones which can be built only under the assumption of direction independence of secondary dichords. After all, the categories of modal types of movement and the employment of directionality for the interpretation of Hurrian notation are mutually exclusive. But as we must account for the fact that so large a part of the musical material of the hymns is so easily classified into so few categories, the decision seems clear.

In very similar ways the preponderance of 'second' string descending steps explains itself. Here we find 27 instances for 'first' strings against 42 instances for 'second' strings (cf. Table 7). The majority of 25 cases stems again from parallel movements, mostly the popular descending thirds *(1)*. Then there are two 'first' and three 'second' string instances that are inconspicuous in every respect. The largest contribution to the 'second' string dominance is again caused by the succession between the two neighbouring thirds with opposite 'direction', *šēru* and *šalšatu*, this time of course in obverse order *(1a)*. Once these cases are left out of consideration, the remaining difference is no longer significant at the 5%-level[107]. But this time there is also another factor involved: the second most frequent category of successions (the 'cadential' type) contains a 'second' strings upwards step in several of its manifestations, and namely in the frequent ones. It accounts for no less than eight instances, marked as *(2)* in the table.

dichords	occ.		'first'	'second'	both
rebūtu – embūbu	2	df-cf	1↘	0	
qablītu – kitmu *(4b)*	2	ad-gc	1↘	1↘	1↘
titur qablītu – titur išartu (1)	3	db-ca	1↘	1↘	1↘
isqu – titur qablītu *(1)*	2	ec-db	1↘	1↘	1↘

[107] At 35.06% conjunct descending movement between 'first' strings and 46.75% between 'second' strings, p=0.095.

dichords		occ.		'first'	'second'	both
šalšatu – rebūtu	*(1)*	7	eg-df	1↘	1↘	1↘
šēru – šalšatu	*(1)*	6	fa-eg	1↘	1↘	1↘
titur išartu – serdû	*(1)*	5	ca-bg	1↘	1↘	1↘
šēru – serdû	*(1a)*	6	fa-bg	3↗	1↘	
rebūtu– nīd qabli	*(2)*	4	df-be	2↘	1↘	
šalšatu – embūbu	*(2)*	3	eg-cf	2↘	1↘	
qablītu – isqu		1	ad-ec	4↗	1↘	
šēru– išartu	*(2)*	1	fa-dg	2↘	1↘	
serdû – rebūtu		1	bg-df	2↗	1↘	
titur išartu – šalšatu (?)[108]		1	ca-eg	2↗	1↘	
			Total 1↗	27	42	25

Table 7. Dichord successions resulting in descending conjunct motion in 'first' and 'second' strings.

Thus we arrive at a complete explanation of the large amount of 'second' string conjunct motion found in the data. It results partly from the break of symmetry that is inherent in the 'mathematical text', and partly from the favour for one specific type of movement, which in turn can be understood quite easily as the canonical way of arriving at a primary dichord, perhaps with faint analogies to European harmonic music. As regards this aspect of the data, it is therefore not possible to draw any connection between the notation of the hymns and the order in which the constituent strings of each dichord are given in the 'mathematical text'.

Nor can the absence of repeated 'first' strings be interpreted in this way, since all five instances of iterated 'second' strings involve a progression from *embūbu* to *rebūtu* or vice versa. Therefore the critical element for this distinction is obviously not the strings, but the dichords. We have already seen that sequences that establish a chord (a fifth built from two thirds) are almost entirely avoided. Now it is clear that the great majority of combinations with iterated strings fall into this category: it contains all fifths in combination with one of their 'constituent' thirds, and all combinations of thirds that together form a 'chord'. Yet of the non-chordal type there are only two possible combinations with iterated 'second' strings. One of them is that which we have discussed, and of which five examples are indeed attested. The other one involves the extremely infrequent *išartu*, so it is no wonder that no single instance is found. Non-chordal iterated 'first' strings, on the other hand, are possible only between *rebūtu* and *išartu*: and, given the

[108] Included, in this form, by West 1994, 176, but more probably reading *išartu – šalšatu* (Laroche 1973, 125), with conjunct '*first*' string movement and constant 'second' string.

scarcity of *išartu*, we do not expect to find any instances[109]. The combination of *embūbu* and *rebūtu* appears as preferred[110]; but the missing repeated 'first' strings are fully explained by the observed avoidance of 'chords'.

So we can finally assert that there is no influence of dichord 'directionality' on the Hurrian notation at all. All the same it must be regarded as highly plausible that the vocal melody coincided with one of the notes of the notated dichord at least at the point when this dichord was played at the first time – but the notation contains no clue as to which note this was.

At some points in the hymns, certain dichords are further qualified by the Hurrian terms *ašḫue* and *durie*, meaning something like 'upper' and 'lower'. These terms are absent from the best preserved hymn 6, and from all hymns whose tuning statement is extant. There is however no reason to assume that they appeared only in non-*nīd qabli* pieces (cf. Table 8).

Hymns with	qualified dichords	no qualified dichords
nīd qabli tuning	3	0
no tuning specified	22	6

p=0.512 (Fisher's exact test)

Table 8. Extant tuning statement and qualifications[111].

The qualifications are only attested with three dichords: six times with *šēru*; twice with *rebūtu*; and once with *serdû*. All of these are secondary dichords; but other secondary dichords never appear with one of these terms, even if they are no less frequent; and with no dichord is a qualification obligatory. So what are the principles behind this startling distribution?

	primary	secondary
qualified	0	9
not qualified	39	73

p=0.0259 (Fisher's exact test)

Table 9. Qualifications of primary and secondary dichords.

[109] The expectations are: *embūbu* & *erbūtu*: 1.65 instances; *šalšatu* & *išartu*: 0.17; *erbūtu* & *išartu*: 0.17.

[110] 5 instances at an expectance of 1.65: p=0.0249.

[111] For this calculation, the fragment RŠ 19.164y has not been counted for methodological reasons: it could belong to one of the numbered hymns and can therefore not be put into the same category with them.

	šēru	*šalšatu*
qualified	6	0
not qualified	13	16

p=0.0167 (Fisher's exact test)

Table 10. Qualifications of the secondary dichords *šēru* and *šalšatu*.

Firstly, it is of interest that a differentiation between primary and secondary dichords is not as significant as the difference between the secondary dichords *šēru* and *šalšatu* (cf. Table 9 and Table 10). This detail strongly suggests that the applicability of a qualification to a specific dichord has not much to do with its type. But there is another feature which the three qualified dichords share: they include one note that forms, in *nīd qabli* tuning, part of the tritone, and has therefore only one resonant counterpart of the fifth/fourth type. Such a classification must seem far-fetched at first; but it can be proven that it is the best description of the phenomenon proposed so far.

Let us recall the fundamental facts: the tritonal dichord in *nīd qabli* tuning is *pītu*, including the strings 7 (f=FA) and 4 (b=SI). The qualified dichords are *šēru* 7–5, *rebūtu* 2–7, and *serdû* 4–6. Of course there are also other dichords that contain either string 4 or string 7, namely *embūbu*, *nīd qabli*, and *titur qablītu*, none of which is attested with a qualifying term. Even so a categorization according to this criterion is most satisfactory, even and especially if the primary dichords are included (cf. Table 11).

Secondary dichords

	with 4/7	without 4,7
qualified	9	0
not qualified	45	28

p=0.0181 (Fisher's exact test)

Primary and secondary dichords

	with 4/7	without 4,7
qualified	9	0
not qualified	65	47

p=0.0098 (Fisher's exact test)

Table 11. Tritone and qualification of dichords.

Unfortunately, the context of the qualifying terms is almost always lost. Only in three cases are we able to determine not only the qualified dichord, but also the preceding one. Nevertheless, these provide strong support for our hypothesis: the

preceding dichord invariably also contains either string 7 or 4, and never the same one as the qualified dichord. The instances in detail[112]:

h.10.5	*nīd qabli 2 šēru durie*	4 1 – 7 5 lower	eb–af
h.10.6[113]	*nīd qabli 1 rebūtu ašḫue*	4 1 – 2 7 upper	eb–df
h.19.7	*serdû 5 šēru ašḫue*	4 6 – 7 5 upper	bg–af

The whole corpus of notation contains twelve dichord successions that include the tritone in such an implicit way. So the three cases in which the second dichord is actually qualified constitute no less than one quarter; which makes it possible to assess the significance of the relation in spite of the paucity of the material (cf. Table 12). It is therefore plausible that the qualifications as 'upper' or 'lower' were used for a great part or even exclusively in contexts where notes of two successive dichords formed the 'unclear' tritone.

second dichord is		
	not qualified	qualified
tritonal	9	3
not tritonal	44	0

p=0.0079 (Fisher's exact test)

Table 12. Tritonal successions and dichord qualifications[114].

Only one example is preserved where we can be certain about the dichord that follows a qualification. This dichord also contains one of the boundary notes of the tritone[115]. Unfortunately the name of the qualified dichord is lost in this case; and in the three cases where it is preserved the subsequent one is lost: so we are never able to determine the whole context. Consequently, it is equally possible that the one extant following dichord contains the 'tritonal' string only by chance, or that only the central ones of series of three dichords joined by two 'tritonal' progressions were qualified.

[112] The mutilated cases are compatible with such an exclusive rule: in h.10.8 the preceding dichord of the sequence "]-*te* 2 *ir-bu-te du*-[*ri-e*" could have been *serdû* (*zi-ir-te* in the orthography of the hymns), and in h.13.1 "]-*te* 2 [*ša?-aḫ?-r*]*i? aš-ḫu-wə* 2" either *serdû* or *rebūtu* (written as *ir-bu-te*).

[113] This instance is missing from the discussion of the qualifications in West 1994, 176, but present in his list of sequences, 175. The reading depends on whether the traces of the broken off sign match only the vertical strokes of the *at* or *it* of *na-at-kab-li/ni-it-kab-li* – as the drawing in Laroche 1968, 489, indicates – or perhaps also the horizontal ones of the *tar* or *ir* of *ti-tar-kab-li/ti-ti-ir-kab-li*.

[114] Here only those dichord successions are counted for which the state of the tablets would allow detecting a qualification after their second member.

[115] Again the incompletely preserved instances do not exclude a dichotomic rule: the dichord following the qualification in h.10.9 "] *du-ri-e* 2 *ša*-[" would then have been *šēru* (written as *ša-aḫ-ri*).

second dichord is		
	primary	secondary
qualified	0	3
not qualified	2	10

p=0.63 (Fisher's exact test)

Table 13. Extant successions with tritonal element[114].

Now we are also in the position to give a more definite answer to the problem of a possible connection between dichord type and qualification. The lack of qualified primary dichords can be explained as resulting simply from the scarceness of sequences with tritonal string progression that lead to a primary dichord (cf. Table 13) – which is in turn partly due to the fact that the tritone *pītu* itself is entirely absent, so that there are less primary than secondary dichords that contain string 4 or string 7. Therefore we should not be surprised to come across a qualified primary dichord if new tablets with notation are discovered.

But why do we find the same successions sometimes with, sometimes without qualification? It seems that the employment of qualifications is a principal choice that must be made for each piece, or perhaps by each scribe. For no hymn that contains a qualification at one point omits it at another point where it would be applicable according to our interpretation. Where the terms are employed at all, they tend to occur more than once: thrice in hymn 4, four times in hymn 10, and twice in hymn 19. Only where there is very little notation preserved do we find single instances: in hymns 5, 13, and 30. And on the other hand, there is no example in the long runs of notation of hymns 6 and 8, which contain nine exploitable 'tritonal' successions[116].

cuneiform signs used for	hymns with qualifications	hymns with not qualified tritonal successions
standard notation	174	202
extended notation	28	5

χ^2=18.06 p=0.000021

Table 14. Cuneiform signs for standard and additional notation.

[116] A tenth one is broken at the end, so that we cannot determine whether it was qualified. These two hymns contain even 'tritonal' triplets with alternating tritone boundary strings: h.6.8 *rebūtu – nīd qabli – šēru*, and h.8.15 *šēru – serdû – šēru*, both including a sequence of strings 7–4–7 (cf. also *rebūtu – nīd qabli – titur qablītu* in h.6.7, with 7–4–4). Only this makes it entirely certain that the absence of qualifications in these hymns is not by accident, since we cannot a priori exclude that only triplets were qualified.

The state of the rest of the pieces cannot be determined with certainty: either what is left of them contains no 'tritonal' successions at all, or these are broken at the right end, where the qualification of the second dichord would be found. Nevertheless there is a clue to the classification of some of them: where the notation uses the two 'standard' qualifications, we also find a greater amount of other additional remarks (in Hurrian or "barbarized" Akkadian), the meaning of which remains obscure[117]. In contrast, hymns 6 and 8 lack such remarks, with the exception of the seemingly quite common *uš-ta-ma-a-ri*. If the amount of text and such remarks is quantified by (extant) cuneiform signs, the relationship can be measured and subjected to a simple statistical test[118]. The data are displayed in Table 14, where dichord names, numbers and – for the sake of the argument – the qualifications *ašḫue* and *durie* are counted as standard notation. In the two pieces that do not use those two qualifications the proportion of other remarks amounts to only 2.4%, as opposed to 13.9% in the tablets with extended notation. Accordingly, we can expect that tablets with a high amount of non-standard notation will also have employed the two basic qualifications where necessary[119].

How to interpret this dichotomy? Perhaps the hymns are divided into two different musical styles, one of which required more detailed specifications; or they were even performed on different instruments. Or perhaps the differences reflect just more or less scrupulous ways of writing down the music, possibly reflecting different stages in an ongoing evolution – we must bear in mind that the Ras Šamra notation may well have been a novelty.

It is noteworthy in this context that there is a certain correlation between the type of notation and the person of the scribe who wrote the respective tablets. Two of the ascribed pieces bear the name of Ipšali, and both use the extended type[120]. On the other hand, the two tablets with simple notation are written by different hands. This may be due to chance; but at least we should note that there is no evidence that both types of notation were ever used by the same person.

[117] Apart from the qualifications, which stand between a dichord and its number, we can distinguish three types on structural grounds: they can stand in the place of a dichord (*ḫapšema*? but cf. Güterbock 1970, 49–50), in the place of a number (*pugarna*), or between dichord-number blocks (most of the rest). Cf. Kilmer 1971, 144–145; Wulstan 1971, 374; West 1994, 171–172.

[118] It is admittedly not unproblematic to base a test on syllabic signs rather than structural units of the notation. Still at the present stage it is the only possible approach, first because any attempt of dividing sequences of terms of unknown meaning into structural units must be subjective, and also because such units would include items so different in size and meaning as simple numbers and perhaps more complex expressions like *e-ta-ma-še-a-ni*. Since the notation seems to contain no logograms, the division at the level of the signs grants unequivocal units of practically identical extension.

[119] Such pieces are for instance hymns 2 and 26.

[120] Hymns 13 and 19. Not much of the music of h.12, also written by Ipšali, is extant; but it contains the word *[ḫap?]-še-ma*, which makes it also a plausible candidate for extended notation.

I can offer no water-tight explanation for the actual meaning of the concepts of 'upper' and 'lower'. It will have been observed that there is no detectable pattern in the connection between the two strings in question and the two possible qualifying terms[121]. But this is rather to be expected: if the implications were mechanical they need not have been notated. The 'tritonal' type of harmonic progression in which the qualifications appear is, as such, neither sought nor avoided[122]. One might assume that the terms describe some way to avoid the synchronous sounding of the two strings that form the tritone, presumably by dampening one of them. But most progressions from one dichord to the other included at least one discordant step anyway, usually a second (we remember that precisely the more resonant combinations, those forming chords, are avoided). And I see no way to reconcile the evidence with such an assumption.

We can further try to relate the qualifications to differences in pitch. The crucial notes, f = FA and b = SI, are those which are altered alternatively to obtain one of the 'neighbour' tunings in the retuning cycle: raising f to f♯ results in the 'key one fifth above', lowering b to b♭ in the 'key one fifth below'. Consequently, these alternative notes are also the natural candidates for the simplest types of modulation in diatonic music. The musicians, who start from the traditional heptatonic scale, will easily perceive the new situation as a kind of 'doubling' of the note. Hence, old b was split into a *b durum* and a *b molle* in European Medieval music, and the same concept still underlies the system of sharps and flats of staff notation, which indicate differences of pitch by qualification of a basic note, whose position on the staff does not change[123].

It is conceivable that the musical culture in which the Hurrian hymns originated had taken the first steps of modulation: those that included the neighbour keys. After many centuries of intimate acquaintance with the complete retuning cycle this would by no means be surprising[124]. Such an assumption can solve some of the riddles of our qualifications:

[121] In the extant sequences, string 4 is followed by string 7 in the qualified dichord. But where *serdû* (4 6) is qualified (h.30.2), this was not the case.

[122] 21 instances are found, 17.48 expected: p=0.207.

[123] In Ancient Greek music the three genera complicate the picture. But there, too, the modulation between 'the note one tone above a' and 'the note immediately above a' was perceived as so basic that it was categorized differently from other 'modulations of key'. In the diatonic genus it is reduced to the difference between b and b♭. The modulation from f to f♯ must have been common in the fifth century BC; its theoretical background was obviously already present in Eratoklēs' work (Aristoxenos, Harm. 1,5, p.9,16–20 da Rios). Cf. West 1992a, 26–27; Hagel 2000, 52–58.

[124] By the term modulation, I imply more than just a retuning of the instrument between different sections of one performance, as envisaged by Kilmer 1997, 470–471; cf. the discussion by Černý 1994, 18–19. While the latter is not very different from performing two songs of different tuning one after the other, we are dealing here with the idea of more or less free movement between two tunings or scales within one melodic/harmonic line.

- Firstly, it explains why only dichords are qualified that include either the f = FA or the b = SI. It goes without saying that, as long as only these two notes are changed, modulation was nicely compatible with dichordal notation: in all dichords that we find qualified it is clear which string is the altered one. (Only the tritonal *pītu* would require further information, since it can be turned into two different fourths, depending on which of its boundary notes is replaced by its substitute. One could suppose that the remaining assortment of ill-understood terms contains designations for one or both types of altered *pītu*[125]; but we will see that no such assumption need be made.)
- Secondly, this hypothesis accounts for all attested combinations. Every dichord that contains one of the crucial strings can appear in both of its variants, with one exception: the eponymous dichord, in our case *nīd qabli*, would become a tritone. And indeed the hymns contain no instance of qualified *nīd qabli*.
- Thirdly, the existence of two groups of hymns, those with simple and those with extended notation, finds a natural explanation: Most of the additional terminology would only be required in modulating pieces. The famous hymn 6, which forms our image of ancient Near Eastern music, would then simply represent a less sophisticated style.
- Finally, the observed tendency of the extant dichords before and after qualified ones to contain also one of the crucial strings, and as far as we see always the other one, can be understood from the technique of modulation: since the modulating note is defined as establishing the pure interval where otherwise the tritone is located, the corresponding note of the tritonal dichord is the typical starting point for a modulation. In this case we expect that the occurrence of qualified intervals in 'tritonal' successions is indeed only a tendency and not an exclusive rule: at least for the 'natural' variant of the dichord there is no reason to stand always in a sequence of this type.

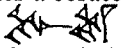
The last point demands further consideration and a thorough investigation of the few cases with extant context. At the same time, it leads us to the question if we can determine which term stands for the natural, and which for the modulating type of dichord. Only if the 'accidental' hypothesis is supported by every level of the evidence can it be put forward seriously.

[125] To account for the complete tuning cycle it would of course not be necessary to have additional names for every dichord: the same term or pair of terms could be reused for the respective tritone in any basic tuning.

dichord contains is	f=FA	b=SI
qualified	8	1
not qualified	1	10

p=0.00060 (Fisher's exact test)

Table 15. Qualification of dichords with string 4 or 7 in hymns containing qualifications.

So far we have always considered both boundary notes of the tritone together. But a closer inspection reveals an enormous discrepancy (see Table 15): there is just a single instance of a qualified dichord with b=SI, and on the other hand in those hymns which employ qualifications at all, only once a dichord with f=FA has no qualification. The latter can easily be accounted for either by a scribal error (cf. the missing number after a dichord in hymn 21.6), or by intentional omission because the correct reading was ensured by the context (cf. the omission of all but the first accidentals within a bar in staff notation). The unique qualified b=SI poses a more serious problem. Although the hymns might conceivably have contained both f sharps and b flats, such an assumption can hardly be based on only one case, especially as hymn 30, from which it stems, contains a qualified dichord with f=FA, too: so it would be impossible to divide the pieces nicely into scores with 'one sharp' and 'one flat'. Therefore, the evaluation of the evidence indicates that there might something be wrong with the single qualified b=SI – and this independently of the interpretation one prefers. And indeed the reading of the relevant passage is far from certain. Laroche prints the second line as "*zi-i*]*r-te du-ri-e* ["[126]. As his copy shows, the reading of *ir* is based on two thin lines that extend from the broken end of the margins and are interpreted as the remains of parallel wedge strokes:  . But these do not really resemble the corresponding strokes in *-ir-te* in the line above and below, which appear in the copy as  and  [127]. If (at least) one of the strokes in line 2 is rather a scratch or a fissure the correct reading will be "*ir-b*]*u-te du-ri-e* [", (cf. e.g  *-bu-te* in hymn 6.5[128]). This is then just another example of a qualified f=FA dichord.

Under the assumption that the modulating interpretation is correct, it seems therefore very plausible that the music of the hymns knew only one type of modulation, achieved by shifting the f=FA of the basic tuning to an f♯. Consequently, there would be no need for two alternative names for *pītu*. In any case, the absence

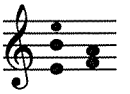
[126] Laroche 1968, 476; but cf. Güterbock 1970, 48 note 6. 50.

[127] From Laroche 1968, 496. Even where the horizontal strokes of *ir* are parallel, as for instance in h.7, they appear considerably closer to the top of the line.

[128] Laroche 1968, 487.

of this dichord is sufficiently explained by the small amount of preserved modulating music[129]. Since there are seven possible different intervals that include either f or f♯, namely *šeru ašḫue*, *šeru durie*, *rebūtu ašḫue*, *rebūtu durie*, *embūbu ašḫue*, *embūbu durie*, and the variant *pītu*, and since the hymns with attested qualifications contain only a dozen dichords with f = FA, the absence of any particular one is not significant[130]. After all, there is, as well, no instance of qualified *embūbu*.

But which of the two terms designates the ordinary and which the modified dichords? Naturally we expect the modulating form to be less frequent: the basic tuning should assert its state by accounting for the greater part of the music[131]. This would point to *durie* indicating the natural variant – but the difference between the attested five instances of *ašḫue* and seven of *durie* is not really expressive. Unless new material be discovered there is little hope for certainty. But as much as can be inferred at all from the few preserved contexts, they seem to support *ašḫue* as the marker for the modified versions, too. For in three cases, we find the term *ašḫue* in the immediate neighbourhood of a b = SI, but *durie* only once. Furthermore, the progression underlying the latter case has good parallels in non-modulating music: the combination *nīd qabli – šēru durie* from hymn 10.5 recurs in hymn 6.8 as *nīd qabli – šēru*[132], according to the present hypothesis in both cases to be transcribed as



Such a progression is most easily perceived as combining two convergent conjunct movements, an ascending one from e = MI to f = FA and a descending one from b = SI to a = LA, so that a fifth 'closes up' to a third. No essential relation need be assumed between the 'tritonal' notes; and as we find no similar figures at different places in the scale, we will interpret the progression as just another way of departing from the basic primary *nīd qabli* into the realm of secondary dichords.

Quite different is the case of hymn 10.6 *nīd qabli – rebūtu ašḫue*. Here no *ašḫue*-free counterpart is attested, but this time there are analogous melodic movements[133]:

[129] The term *be-en-ta-(am)-ma* (cf. Laroche 1973, 128) is no good candidate because it occurs together with non-qualified *šēru* (h.3) and *rebūtu* (h.2 and 25), in obviously not modulating hymns.

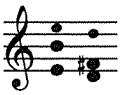
[130] A binomial test yields p = 0.157.

[131] This argument is not entirely cogent. A situation can be envisaged in which only one direction of modulation can be notated, while the opposite direction is employed, too. In such a case the basic key must be a modulating one. But such an assumption is highly artificial. It is much more likely that alternative ways of notation are designed which maintain what the performing musician considered as the basic key or tuning.

[132] Cf. also h.2.21.

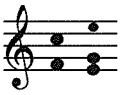
[133] H.6.7. h.2.26.

nīd qabli – rebūtu ašḫue



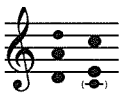
can be compared to

embūbu – šalšatu



and

qablītu – isqu



It will be noticed that in the two related cases the progression includes a falling fourth; an exact parallel can be established only by the inferred sharp.

Less helpful is the third example, *serdû – šēru ašḫue* from hymn 19.7. These fall under the common category of descending thirds. There are four examples of the same progression with natural *šēru*; but on the other hand also eight from major to minor thirds, as is the case here with *ašḫue* interpreted as indicating the sharp variant[134].

In hymn 19.9 only the sequence [X] *ašḫue – serdû* can be read. Here we can only apply the general rule that an f♯ makes good sense before the b of *serdû*, which re-establishes the relation between modulating note and underlying tuning.

To sum up, we see that nothing in the evidence speaks against a modulation hypothesis, nor against the identification of *durie* as the marker for the 'natural' and *ašḫue* for the 'sharp' note[135]. Consequently it seems justified to propose the former as an explanation of several striking aspects of the evidence, and the latter as a working hypothesis, perhaps to be overthrown by future finds.

We do not know whether the music of the hymns was for a harp, a lyre, perhaps a double pipe, or some ensemble of such instruments. That at least one stringed instrument took part seems likely from the employment of musical terms that owe their significance to the exact intonation and clear-cut division of notes, which is not characteristic for the reed-pipe. At the same time it seems clear that of all ancient stringed instruments only the lute allowed playing different notes on one string. There was probably no means at all to adjust the length or tension of harp or lyre strings during playing[136], and certainly no means to achieve a clearly defined note by doing so[137]. Therefore a modulating note should mean an additional string. Our considerations concerning the tuning led us to the conclusion that the

[134] Two times *isqu – titur qablītu*; six times *šēru – šalšatu* (all definitely without qualification).

[135] Cf. the suggestion by Kilmer 1997, 476, to read the terms as "sharp" and "flat". Cf. also Wulstan 1971 374 with note 21.

[136] Pace Hickmann 1961, 96.

[137] For the Greek world, see Winnington-Ingram 1956, who ended the discussion about how to play different notes on Greek lyre strings – a discussion that started only with the theory of pentatony put forward by Curt Sachs, which is now entirely obsolete thanks to the insights into Near Eastern diatonic heptatony. Even if we allow for short pauses between different sections, Kilmer 1992, 107, seems overly optimistic about the possibility to bring one or two strings into a new tuning.

hymns still maintain characteristics that can be understood only from the ambitus that corresponds to the standard nine strings of traditional theory. The data regarding the progression in descending thirds pointed into the same direction. Together with the modulating string, this would make a total of ten (which reminds one of the ten-stringed instrument attested for first-millennium Palestine by the Psalms[138]).

As the lyre strings of Babylonian theory are ordered according to their pitch, a modulating string was presumably inserted alongside its natural counterpart. It will be noticed that such an arrangement destroys the traditional correlation between the number of a string if counted from one end and its melodic value: the old designations lost their practical immediacy and became functional terms. But this is a natural evolution. It happened in much the same way in Greece, where the former 'topmost' string retained its name although more strings were added, until finally the tonal material was described in terms of 'topmost of the middle' (*hypátē mésōn*) versus 'topmost of the topmost' (*hypátē hypátōn*), still exceeded by an 'additional note' (*proslambanómenos*). Similarly, Greek musicians continued to think in tetrachords long after modulating strings had begun to intrude the four-string units of kithara tunings. Although there was presumably no clue in the layout of the instrument that indicated the harmonic relations, the strings remained grouped according to the tetrachordal scheme in the musicians' mind[139]. Where to the uninitiated eye there was only an indiscriminate row of eleven strings, the poet-musician perceived 'crossroads of concordant harmony'[140].

[138] Its name עשור 'decade' usually designates some specific instrument (cf. Sendrey 1969, 289–291), but is found also (Ps 33.2; 144.9) as a qualification of the נבל (Greek νάβλα), a "harp with straight parts and upper soundbox" (Hippolytos fr. *in Ps.* 9, p.140.19–24 Bonwetsch – Achelis), already well known in Greece in the Classical era as an instrument of Semitic origin (Sophocles fr. 765 Nauck = Plutarch, *De E apud Delphos* 394b; Athenaios, *Deipnosoph.* 4.77, 1.393 Kaibel): cf. Sendrey 1969, 278–289; all sources are exemplarily gathered by Bayer 1968, although her identification of the נבל with a lyre shown on Bar Kochba coins is hardly tenable: cf. e.g. Lawergren 1998, 55–56, whose identification with the Near Eastern 'thick lyre', on the other hand, tends to neglect the literary evidence, especially the Septuagint. Although it is possible that a lyre that was never played with a plectrum was perceived as a ψαλτήριον (literally 'plucked instrument', usually the harp), the absence of any representation of a 'thick lyre' in the Greek or even Semitic world (Lawergren 1998, 43) excludes this instrument as a candidate for the *nábla*. Josephus (*Jewish Antiquities* 7.306), on the other hand, attributes twelve strings to the *nábla* harp and ten to the lyre: כנור κινύρα (cf. Sendrey 1969, 268–278; Lawergren 1998, 58, rightly warns of taking Josephus as a witness for pre-Hellenistic instruments). The latter may well have been identical in name with the Hurrian musicians' instrument: for ^{d}GIŠ *ki-na-rum* = *knr* in Ras Šamra and Hurrian *kinnaruḫuli* 'lyre player/maker' cf. Lawergren 1998, 309–310; Kilmer 1983, 573; Tonietti 1997, 483.

[139] It seems that the conception of the tetrachord as a functional unit is very close to musical practice; cf. e.g. already the first extant mention of the fourth (Philolaos fr. 6), where it is called συλλαβά, 'what is taken as a unit'.

[140] Ion of Chios, fr. 32 West. Cf. West 1981, 128 note 86; West 1992, 227; West 1992a, 23–28; Hagel 2000, 52–53.

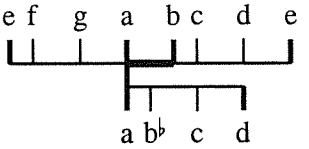
It must also be remembered that the divergence between instrument layout and the string numbers of the system by no means originated solely with modulation. On many instruments with more or fewer than the canonical nine strings the discrepancy must have been there from the beginning. The same holds true for lutes, where one row of strings had to be translated into two or more rows of frets[141]; and the relations must have been especially abstract whenever pipers had to orient themselves toward the dichordal harmonies of their fellow harpers and lyre players[142]. The extremely long life time of the dichordal system as a means of describing the tonal system proves sufficiently that it did not depend on specific instruments (which appear and disappear over the centuries), but had soon evolved into an abstract functional scheme, which continued to be applicable at least to certain types of music. Thus it is clear that the insertion of an additional string could not be perceived as heretical, or fatal for the system.

Insofar as modulation is conceptually related to retuning, the two steps corresponding to f = FA and b = SI in any diatonic scale are in principle equally suited for modification leading into a neighbour key. Now we have inferred that modulation in Hurrian music probably happened by doubling the f = FA, while both in Greek and Medieval Western music it started with b = SI. The difference between the two ancient systems can be understood out of the principles underlying the respective tonal systems. In Greece, the diatonic f = FA was only a 'moving' note: it represented just one possible variant of the second-lowest note of its tetrachord. On the other hand, the b = SI was a 'standing' note taking part in the tonal framework of fifths and fourths. Yet modulation was not achieved through 'doubling' any of them by turning the 'tritone' into a pure fourth: this would have required a definite state for both of them, as in the entirely diatonic Babylonian system. For the Greek perception of modulation, the focal note *mésē* a = LA was crucial. All systems could be described as consisting of tetrachords and whole tones. In the standard tuning, *mésē* stands at the top of a tetrachord and below the whole tone.

[141] Structurally there is one row of frets for each string, with the natural restriction that both rows must be equal: hence in diatonic tuning and without additional semitone-steps the strings are naturally tuned in fourths or fifths. Arndt-Jeamart 1992, 439–447, when expounding his theory of over-complicated mathematical constructions of fret positions, seems to overlook the fact that tunings of the lute can be achieved by ear in structurally exactly the same way as on the lyre, only that frets are moved instead of adjusting string tensions (assuming that the few strings of the lute have been brought into their necessary pitch relation beforehand); cf. the retuning procedure applied to the lute as it seems to be alluded to already in Šulgi B 160 (cf. Krispijn 1990, 1. 5–6). Arndt-Jeamart's considerations about geometrically tuning the harp by means of strings of equal tension are completely impracticable.

[142] Apart from the pictorial representations of such orchestras cf. the term *embūbu* 'double pipe', which most likely testifies to a close connection between that instrument and the respective dichord or tuning. Cf. the considerations by Arndt-Jeamart 1992, 433–434, about the applicability of the string nomenclature to different stringed instruments.

If instead of the 'disjunctive' tone another 'conjunct' tetrachord is employed, the melody has changed to the neighbour key:



In the diatonic genus with its tetrachords of the form 'semitone – tone – tone' the resulting scales are the same as those reached by the 'retuning method'. Nonetheless the underlying conceptions are very dissimilar. The difference is the same one that emerged already from the comparison of the two notation systems: the Greek system is centred on melody, not intervals.

But the heart of the Near Eastern system is tuning, retuning, and dichordal harmony. Consequently, modulation is understood in the same conceptual framework. So it seems that the direction of modulation is guided by the peculiarities of the traditional system. In principle, as we have said, both possible directions of tuning and retuning are equal. But within the formulation of the system one direction obtained primacy. The resulting differentiation is already present in the 'mathematical text' in the directionality of primary dichords, which guides the tuning process. It becomes pre-eminent in the retuning text. There, the cycle is described in both directions; but it is very clear that the first one elaborated is also primary in character. Only here, the correction of an 'unclear' dichord results in the tuning that bears the same name, while this fundamental relation is concealed when the retuning cycle is carried out in the opposite direction[143]. It is likely that this same primary direction of retuning, which the Near Eastern musician must have regarded as the 'natural' one, determined also the direction of the first type of modulation to have occurred. If in *nīd qabli* tuning the dichord *pītu* is unclear, and we want to introduce a modulating string to establish a pure *pītu*, it seems the natural thing to do so by establishing an alternative *pītu* tuning at the same time. The alternative process would, by altering the b = SI instead of f = FA, produce the *nīš gabarî* scale, which the fine tuning of the hymns would presumably render particularly useless: as we have seen, its eponymous and very probably focal dichord is not available as a perfect fifth.

Now that our statistical tour through the Hurrian hymns has come to its end, which new insights into Ancient Near Eastern music and its connections to the Classical Greek world did it yield? Our study of fine tuning has shown us that pure thirds were certainly part of the Babylonian musical consciousness, no less than later in Greece. This is no wonder: pure thirds of both types are part of the series of partials; so knowledge of them must arise once horns are blown – al-

[143] In *Nabnītu* 32 and KAR 158, however, the tunings/dichords are listed in the 'secondary' direction, starting from *išartu* 'normal'.

though personally I regard the experience of string resonance alone as sufficient for the constitution of these concords. We have also gained some understanding of the modal structure of *nīd qabli* tuning as used in the Hurrian hymns, and how it is put to work. Although it must be doubted that fine tuning and modality remained completely unchanged for centuries and across cultures even if described by the same basic system, we have found also certain evidence of continuity. Perhaps Hurrian *nīd qabli* is not so far away from earlier stages after all: might Šulgi have recognized the mode of the hymns? Finally, we have put forth a new hypothesis of modulation, which seems to account for those pieces which display extended notation.

Yet in all three fields, fine tuning, modality, and modulation, we have found that Greek and Hurrian music took fundamentally different paths. Since for these matters there is currently no Near Eastern evidence available except the Hurrian hymns, we must state that, as far as our knowledge goes, Greek and Mesopotamian music have not so much in common as is often believed. Both musical cultures share their main types of instruments, and both are based on heptatonic scales, with structural primacy of the diatonic[144]. This alone indicates a historical connection, no doubt; but as we do not know anything about the scale structures of the other surrounding cultures, the connection can hardly be dated.

The Greeks themselves were well aware that their musical culture owed much to foreign influences. The art of the aulos looked back to a Phrygian ancestry which was preserved in 'Phrygian' tunes. The great mythical kitharists Orpheus and Thamyris were Thracians. Strong Lydian connections are proven by the existence of 'Lydian' and 'Mixolydian' modes. But while these elements were completely assimilated and indispensable parts of Greek music, other imports such as Semitic or Egyptian harps kept their foreign aura. Thus, the Greek evidence gives rise to a picture of a certain community of music culture with Anatolia and Thracia, conceivably characterized to some extent by common Indo-European traditions. We do not know anything about Western Anatolian musical systems except what we can infer from the Greek sources, which is little. But insofar there are divergences between Mesopotamian and Greek music, it is a priori more likely that Phrygians and Lydians – not to mention Thracians – belong rather to one cultural sphere with the Greeks, with whom they share also the adaptation of an alphabet with vowels[145].

Organological considerations confirm this model. It has been shown that until well into the first millennium BC lyres stay nicely separated into Eastern and

[144] Franklin 2002; 2002a.

[145] Probably due only to the lack of early material, the strong organological affinities are attested only rather late: the statue group from Boğazköy (late sixth cent.? Bittel 1963) shows a seven-stringed kithara of typical Greek structure and an aulos player with *phorbeiá*; cf. also the Lykian relief (Xanthus, late sixth cent.) with a round-based kithara, which differs from Greek instruments only in the decoration; Akurgal 1961, Abb. 86.

Western types, the former flourishing in the Fertile Crescent, the latter in the Aegean and Anatolia, and further into Europe[146]. Where the Western round-based lyre enters the Levant, it does so in the hand of the Philistines, newcomers from the Aegean world[147].

Similarly the fundamental divergences between the Hurrian and the later Greek treatment of the tonal material speak strongly against a major transfer of musical culture in the early first millennium BC. Heptatony in Greece dates back as far as our evidence goes[148], and so does diatonic music in Mesopotamia. Hence we cannot even exclude a pre-historic origin of this type of music. In the face of extant pentatonic African lyre culture it is perhaps more plausible that the step towards a sevenfold division of the octave was taken in Sumer[149] from where the new technique spread westwards. The famous Cycladic harpers may be a first announcement of the arrival of this highly resonant music in Europe. The Greeks themselves seem to have rejected the harp from earliest times on in favour of the lyre, here perhaps again siding with some of their Anatolian neighbours and relatives[150]. In Mycenaean times at the very latest a heptatonic musical 'koiné' seems to have existed that may have spanned even a considerably larger part of the Mediterranean world. Whether the dichordal system was ever exported to Greece together with the basic tuning procedure in fifths and fourths remains in the dark. In any case, as soon as we know anything about Greek tonal structures, they appear fully emancipated from such a system and have acquired their typical tetrachordal flavour. It may be that this restructuring and the blending of resonant tuning and microtonality, which is so characteristic of the Classical Greek scales, derive from the amalgamation of microtonal scales inherited by the Greek tribes and the diatonic system of Mediterranean high culture[151]. If it was so, the process must be dated rather early, perhaps towards the end of the first half of the

[146] Lawergren 1993; Lawergren 1996; and especially Lawergren 1998. Apart from examples from Italy, cf. Lawergren 1998, 50–51 Fig. 5 cc (Eastern Alps) and hh (Scythia), and the round-based Germanic lyres (cf. e.g. Lawson 2005), attested much later, but showing closer affinities to the Aegean of Homeric times than to later Greek and Roman instruments. The "end of the strict East–West lyre segregation" in the late eighth century BC (Lawergren 1998, 47) is by no means marked by a wave of Oriental influence in the Aegean: no Eastern type is found there. If the flat-based rectangular 'Italiote kithara', which is not attested before the fourth century cent., is indeed connected to the Eastern 'thin lyre' (cf. West 1992, 56; Lawergren 1993, 69), it might have been imported from Carthage. The 'Thracian kithara' (cf. Maas – Snyder 1989, 145–147; West 1992, 55) is often flat based (like the 'concert kithara'), but similar to Greek round-based lyres in all other respects.

[147] Lawergren 1998, 51–55.

[148] Seven strings are clearly depicted on the lyre on the Hagia Triada Sarcophagus (ca. 1400BC). This lyre is in several respects similar to Greek lyres from the first millennium, and unlike all known contemporary or later Eastern types.

[149] Cf. e.g. Kilmer 1971, 147–148.

[150] Cf. Martino 1997, 485.

[151] Franklin 2002a, 446.

second millennium BC. Still, we have to bear in mind that this was not the view of the Greeks themselves, who regarded enharmonic microtonality as the ultimate result of a process that started from diatonicism in historical times[152].

Finally, in the Roman Imperial period we witness the decay of the Greek tetrachordal system, combined with a renewed tendency towards diatonic scales, which are finally the only ones to survive into Western Medieval and modern music. Perhaps it are the Italic or other European variants of diatonic music that prevail here – but it might also have been a new wave of Near Eastern diatonicism, imported into the world of the Late Roman Republic and the Empire together with so many other elements of Oriental culture.

ABSTRACT

A mathematical analysis of the notational sections of the 'Hurrian hymns' yields new insights in several aspects of Near Eastern music from the second millennium BC. The fine tuning of the accompanying instrument(s) can be determined, as well as a coherent system of 'harmonic' progression. The pieces with 'extended' notation seem to include modulation to a neighbouring key. A comparison with ancient Greek music suggests a largely independent development of musical form from at least as early as the first half of the second millennium on.

الخلاصة

تقدم تحليلات رياضية لمقاطع «التراتيل الحوريّة» المدوّنة موسيقياً توضيحات لوجوه عدّة من موسيقى الشرق الأدنى في الألف الثاني قبل الميلاد. إذ يمكن تحديد النغم الناعم للآلة أو الآلات المرافقة لها، كذلك تحديد أسلوب مترابط لتعاقب منسجم. وتظهر المقطوعات ذات التدوين الموسيقي الممدود وكأنها تتضمن انتقالاً إلى نغمة مجاورة. وتوحي المقارنة بالموسيقى الإغريقية القديمة بتطوّر مستقلّ بشكل كبير لصيغة موسيقيّة اعتباراً من النصف الأول للألف الثاني ق.م على الأقل.

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[152] Cf. Franklin 2002a, 447. 449.

BIBLIOGRAPHY

Akurgal, E.
1961 Die Kunst Anatoliens, Berlin.

Arndt-Jaemart, J.
1992 Zur Konstruktion und Stimmung von Saiteninstrumenten nach den mesopotamischen Keilschrifttexten, Orientalia 61.4, 425–447.

Barker, A.
1984 Greek Musical Writings I, Cambridge.
1989 Greek Musical Writings II, Cambridge.
1995 Heterophonia and Poikilia: Accompaniments to Greek Melody, in: B. Gentili – F. Perusino (eds.), Mousike. Metrica ritmica e musica greca. Pisa/Roma, 41–60.

Bayer, B.
1968 The Biblical Nebel, Yuval [1]. Jerusalem, 89–131.

Bittel, K.
1963 Phrygisches Kultbild aus Boğazköy, Antike Plastik 2, 7–21.

Černý, M. K.
1987 Das altmesopotamische Tonsystem, seine Organisation und Entwicklung im Lichte der neuerschlossenen Texte, Archív Orientální 55, 41–57.
1988 Probleme der Musikaufzeichnung aus Ugarit. Versuch einer neuen Interpretation des „Hymnus h 6", in: Šulmu, 49–62.
1994 Some Musicological Remarks on the Old Mesopotamian Music and Its Terminology, Archív Orientální 62, 17–26.

Collon, D.
1997 s. v. Musik. I. B. Archäologisch, in: Reallexikon der Assyriologie und Vorderasiatischen Archäologie 8, 488–491.

Crocker, R. L.
1978 Remarks on the Tuning Text Ur Excavation Text VII 74 (U. 7/80), Orientalia 47, 99–104.
1997 Mesopotamian Tonal Systems, Iraq 59, 189–202.

Crocker, R. L. – Kilmer, A. D.
1981 The Fragmentary Music Text from Nippur, Iraq 43, 79–83.

DAGM Pöhlmann, E. – West, M. L., Documents of Ancient Greek Music, Oxford 2001.

Devine, A. M. – Stephens, L. D.
1994 The Prosody of Greek Speech, New York/Oxford.

Dietrich, M. – Loretz, O.
1975 Kollationen zum Musiktext aus Ugarit, Ugarit-Forschungen 7, 521–522.

Duchesne-Guillemin, M.
1963 Découverte d'une gamme babylonienne, Revue de musicologie 49, 3–17.
1966 A l'aube de la théorie musicale: concordance de trois tablettes babyloniennes, Revue de musicologie 52, 147–162.
1969 La théorie babylonienne des métaboles musicales, Revue de Musicologie 66, 2–11.
1975 Les problèmes de la notation hourrite. Revue d'Assyriologie 69, 159–173. Here cited after: Duchesne-Guillemin 1999, 369–384.

1977 Déchiffrement de la musique babylonienne. Accademia Nazionale dei Lincei, Quaderno 236. Here cited after: Duchesne-Guillemin 1999, 385–408.
1984 A Hurrian Musical Score from Ugarit: The Discovery of Mesopotamian Music, Sources from the Ancient Near East No. 2, 1–32. Here cited after: Duchesne-Guillemin 1999, 417–447.
1988 Réfutation de l'interprétation Kilmer du chant hourrite, in: Humour, travail et science en orient, 269–276. Here cited after: Duchesne-Guillemin 1999, 409–415.
1999 Monumentum Marcelle Duchesne-Guillemin. Acta Iranica 34 = 3.19.

Finkel, I. L. – Civil, M.
1982 The Series SIG$_7$.ALAN = *Nabnītu*, Materials for the Sumerian Lexicon XVI.

Franklin, J. C.
2002 Diatonic Music in Greece: A Reassessment of Its Antiquity, Mnemosyne 55, 669–702.
2002a Musical Syncretism in the Greek Orientalizing Period, in: E. Hickmann – A. D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 403–451.
2005 Hearing Greek Microtones. In: S. Hagel – Ch. Harrauer (eds.), Ancient Greek Music in Performance. Vienna, 9–50.

Gurney, O. R.
1968 An Old Babylonian Treatise on the Tuning of the Harp, Iraq 30, 229–233.
1994 Babylonian Music Again, Iraq 56, 101–106.

Gurney, O. R. – West, M. L.
1998 Mesopotamian Tonal Systems: A Reply, Iraq 60, 223–227.

Güterbock, H. G.
1970 Musical Notation in Ugarit, Revue d'Assyriologie 64, 45–52.

Hagel, S.
2000 Modulation in altgriechischer Musik, Frankfurt am Main.
2001 Zur physikalischen Begründung der pythagoreischen Musikbetrachtung, Wiener Studien 114, 85–93.
2002 Musik zwischen Apollon und Dionysos – Der delphische Paian des Athēnaios. In: E. Hickmann – A. D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 403–411.
2004 Calculating Auloi – The Louvre Aulos Scale. in: E. Hickmann – R. Eichmann (eds.), Studien zur Musikarchäologie 4. Orient-Archäologie 15, 373-390.
2005 Twenty-four in Auloi. Aristotle, Met. 1093b, The Harmony of the Spheres, and the Formation of the Perfect System, in: S. Hagel – Ch. Harrauer (eds.), Ancient Greek Music in Performance, 51–91.

Hickmann, H.
1958 La chironomie dans l'Egypte pharaonique, Zeitschrift für Ägyptische Sprache und Altertumskunde 83, 96–127.
1961 Ägypten, Musikgeschichte in Bildern 2.1.

Husmann, H.
1961 Grundlagen der antiken und orientalischen Musikkultur.

Jan, C. von (ed.)
1895 Musici scriptores Graeci.

Kilmer, A. D.
1960 Two New Key Lists of Mathematical Operations, Orientalia 29, 273–308.
1965 The Strings of Musical Instruments: Their Names, Numbers, and Significance, in: Studies in Honour of Benno Landsberger. Publications of the Oriental Institute of the University of Chicago, Assyriological Studies 16, 261–268.
1971 The Discovery of an Ancient Mesopotamian Theory of Music, Proceedings of the American Philosophical Society 115, 131–149.
1977 The Cult Song with Music from Ancient Ugarit: Another Interpretation, Revue d' Assyriologie 68, 69–82.
1982 A Music Tablet from Sippar(?): BM 65217 + 66616, Iraq 46, 69–80.
1983 s. v. Leier. A. Philologisch, in: Reallexikon der Assyriologie und Vorderasiatischen Archäologie 6, 571–576.
1992 Musical Practice in Nippur, in: M. deJong Ellis (ed.), Nippur at the Centennial. Philadelphia 1992 = Compte rendu de la 35e Rencontre Assyriologique Internationale [1988], 101–112.
1997 s. v. Musik. A. I. In Mesopotamien, in: Reallexikon der Assyriologie und Vorderasiatischen Archäologie 8, 463–482.
2000 Continuity and Change in the Ancient Mesopotamian Terminology for Music and Musical Instruments, in: E. Hickmann *et al.* (eds.), Studien zur Musikarchäologie 2. Orient-Archäologie 7, 113–117.
2001 Mesopotamia, in: The New Grove Dictionary of Music and Musicians, 2nd ed., 16, 480–487.
2002 Modal Music, Tonality and Genre in Mesopotamian Musical Performance, in: E. Hickmann – A. D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 481–486.

Kilmer, A. D. – Civil, M.
1986 Old Babylonian Musical Instructions Relating to Hymnology, Journal of Cuneiform Studies 38, 94–98.

Kilmer, A. D. – Tinney, S.
1996 Old Babylonian Music Instruction Texts, Journal of Cuneiform Studies 48, 49–56.
1997 Corrections to Kilmer/Tinney 'Old Babylonian Music Instruction Texts' JCS 48 1996, Journal of Cuneiform Studies 49, 118.

Krispijn, Th. J. H.
1990 Beiträge zur altorientalischen Musikforschung 1. Šulgi und die Musik, Akkadica 70, 1–27.
2002 Musik in Keilschrift. Beiträge zur altorientalischen Musikforschung 2, in: E. Hickmann – A.D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 465–479.

Kümmel, H. M.
1970 Zur Stimmung der babylonischen Harfe, Orientalia 39, 252–263.

Laroche, E.
1955 Le palais royal d'Ugarit, 3, Paris.
1968 Documents en langue hourrites provenant de Ras Shamra, in: Ugaritica 5, 447–544.
1973 Études hourrites: notation musicale, Révue d'Assyriologie 67, 124–129.

Lasserre, F.
1988 Musica Babilonese e Musica Gre-

ca, in: B. Gentili – R. Pretagostini (eds.), La musica in Grecia, 72–95.

Lawergren, B.
1993 Lyres in the West (Italy, Greece) and the East (Egypt, the Near East), ca. 2000 – 400 B.C., Opuscula Romana 19.6, 55–76.
1996 s.v. Leier (Altertum), in: L. Finscher (ed.), Die Musik in Geschichte und Gegenwart 5. 2nd ed., 1011–1038.
1998 Distinctions among Canaanite, Philistine, and Israelite Lyres, and Their Global Lyrical Contexts, Bulletin of the American Schools of Oriental Research 309, 41–68.

Lawson, G.
2005 Ancient European Lyres: Excavated Finds and Experimental Performance Today, in: S. Hagel – Ch. Harrauer (eds.), Ancient Greek, Music in Performance, 93–119.

Maas, M. – Snyder, J. M.
1989 Stringed Instruments of Ancient Greece.

de Martino, S.
1997 s. v. Musik. A. III. Bei den Hethitern, in: Reallexikon der Assyriologie und Vorderasiatischen Archäologie 8, 483–488.

Psaroudakēs, S.
2004 The Orestes Papyrus: Some Thoughts on the Dubious Musical Signs, in: E. Hickmann – R. Eichmann (eds.), Studien zur Musikarchäologie 4. Orient-Archäologie 15, 471-492.

Rocconi, E.
2002 The Development of Vertical Direction in the Spatial Representation of Sound, in: E. Hickmann – A. D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 389–392.

Sendrey, A.
1969 Music in Ancient Israel.

Shaffer, A.
1981 A New Musical Term in Ancient Mesopotamian Music, Iraq 43, 79–83.

Shehata, D.
2002 Contributions to the Music Theory System of Mesopotamia, in: E. Hickmann – A. D. Kilmer – R. Eichmann (eds.), Studien zur Musikarchäologie 3. Orient-Archäologie 10, 487–496.

Smith, J. C. – Kilmer, A. D.
2000 Laying the Rough, Testing the Fine (Music Notation for CBS 10996), in: E. Hickmann – R. Eichmann (eds.), Studien zur Musikarchäologie 1. Orient Archäologie 6, 127–144.

Thiel, J.
1977 Der Text und die Notenfolgen des Musiktextes aus Ugarit, Studi Micenei ed Egeo-Anatolici 18, 109–136.

Tonietti, M. V.
1997 s. v. Musik. A. II. In Ebla, in: Reallexikon der Assyriologie und Vorderasiatischen Archäologie 8, 482–483.

Vitale, R. G.
1980 La Tablette 'Musicale' H 6 (RS 15.30 + 15.49 + 17.367), Annales Archéologiques Syriennes 29–30, 41–62.

Vitale, R.
1982 La musique suméro-accadienne. Gamme et notation musicale, Ugarit Forschungen 14, 241–263.

West, M. L.
1981 The Singing of Homer and the Modes of Early Greek Music, Journal of Hellenic Studies 101, 113–129.
1992 Ancient Greek Music, Oxford.
1992a Analecta Musica, Zeitschrift für Papyrologie und Epigraphik 92, 1–54.
1994 The Babylonian Musical Notation and the Hurrian Melodic Texts, Music & Letters 75, 161–179.

Winnington-Ingram, R. P.
1936 Mode in Ancient Greek Music, Cambridge.
1956 The Pentatonic Tuning of the Greek Lyre: A Theory Examined, Classical Quarterly 6, 169–186.

Wulstan, D.
1966 The Tuning of the Babylonian Harp, Iraq 30, 215–228.
1971 The Earliest Musical Notation, Music & Letters 52, 365–382.