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Corpus analysis as a method for describing multipart folk songs: the case of the Moksha pentatonic songs

Abstract

Questo contributo esplora le possibilità di applicazioe del metodo *Corpus Analysis* alle tradizionali canzoni multiparte e offre alcuni risultati di tale metodologia applicata alle canzoni multiparte dei Moksha-Mordvins, un gruppo etnico finno-ungarico che vive nella regione russa del Volga. Il materiale musicale discusso in questo studio deriva dal lavoro sul campo svolto in Mordovia tra il 2015 e il 2020, durante il quale un grande numero di canzone mordove è stato registrato attraverso una tecnologia multicanale. Questo materiale è completato dalla collezione di trascrizione di canzoni Moksha, pubblicata da Nikolai Boyarkin negli anni Ottanta del secolo scorso. L'analisi si concentra sulle strutture armoniche delle canzoni pentatoniche Moksha, che appartengono alla fase più antica. Attraverso la comparazione con due sotto-*corpora*, è possibile delineare i cambiamenti nello stile musicale Moksha nel corso degli ultimi cinquant'anni e spiegare i risultati delle ricerche basati sulla conoscenza di questa cultura.

parole chiave canzoni tradizionali, canto multiparte, *corpus analysis*, Moksha-Mordvins, popolazione ugro-finnica

Summary

This paper explores the possibilities of applying the method of corpus analysis to traditional multipart songs and presents some results of such analysis using as an example the multipart songs of the Moksha-Mordvins, a Finno-Ugric people living in the Volga region of Russia. The musical material of the research originates from our fieldwork in Mordovia in 2015-2020, where a large number of Mordovian songs were recorded using multichannel technology. This material is complemented by the collection of score notations of Moksha songs published by Nikolai Boyarkin in the 1980s. The analysis focuses on the harmonic structure of Moksha pentatonic songs, which belong to the old stylistic layer. Through the comparison of two sub-corpora, we trace the changes in the Moksha musical style over the last 50 years and explain the research findings based on our knowledge of this culture.

keywords traditional songs, multipart singing, corpus analysis, Moksha-Mordvins, Finno-Ugric peoples

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1. Introduction

This paper is an ethnomusicological study that makes limited use of the method of corpus analysis. The corpus method complements conventional methods of musical and ethnocultural analysis in the author's long-term project of studying Moksha multipart singing. The use of corpus analysis and statistical methods addresses the need to obtain additional information about the ethnic musical style under study and its development over the last half century, to test the hypotheses made on the basis of ethnological and music-analytical observation, and to establish the potential of corpus method in the study of polyphonic music of the oral tradition.

The method of corpus analysis, which has been used in music research for several decades, offers specific opportunities for the study of music, both in terms of finding structural patterns and describing styles, and in establishing correlations with cultural context, geographical distribution, and historical and social processes. Both studies of individual musical cultures and cross-cultural comparative studies can be conducted. Corpus analysis makes it possible to analyse large amounts of musical material that would be impossible to work through manually, providing detailed, multifaceted and objective information. Corpus method can be used to test pre-existing hypotheses; however, it can also produce unexpected and even counter-intuitive results.

In recent decades, corpus analysis has become increasingly popular in music research – let us mention here the activities of the International Society for Music Information Retrieval (ISMIR), various publications in the journal *Music Perception* (e.g. its special issues of 2013 and 2014) and in several other journals and books including *The Oxford Handbook of Music and Corpus Studies* (2022, in progress). However, the large majority of corpus analyses have been applied to Western classical and popular music;[1] this can be explained, among other things, by the availability of many large corpora of audio recordings and/or musical transcriptions suitable for computational processing (such as the RISM database, the Free Music Archive, the Yale-Classical Archives Corpus, the Million Song Dataset, the Weimar Jazz Database, and others).

Corpus studies of traditional music are not so numerous, but their number is growing. The topics and results of such research are somewhat limited by the specificity of the available corpora. Among the best-known large corpora of folk tune notations, one of the oldest is Bertrand Bronson's collection of musical transcriptions of about 4000 songs, compiled in the 1950s and 1960s from many different published sources and focusing on British-American folksongs.[2] An extensive corpus often used by researchers is the Essen Folksong Collection, which was compiled by Helmut Schaffrath in the 1980s and 1990s and contains about 6000 transcriptions of European folksongs (mostly German) and about 3000 Chinese folksongs.[3] More recent large corpora

1. SAVAGE, *An Overview*.
2. See BRONSON, *Mechanical Help*.
3. SCHAFFRATH, *The Essen Folksong Collection*. Among the studies based on this corpus are

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of traditional music include the *Digital Archive of Finnish Folk Tunes*, which contains about 9000 folk melodies initially published between 1898 and 1933,[4] and the Frances Densmore collection compiled by a group of researchers in 1998–2013 and consisting of about 2000 songs of different Native American tribes which were first published by Densmore during the first half of the 20th century.[5] There are also other databases of various sizes representing some ethnic musical traditions such as the Ethnomuse archive of the Slovene Academy of Sciences and Arts[6] as well as some small corpora compiled by scholars for their own research.

The common feature of the folk music corpora known to me is that they all represent monophonic vocal and (less frequently) instrumental melodies and, accordingly, can only be used to investigate melodic phenomena. The main feature of the present study is the application of the corpus method to polyphonic traditional music. Without discussing here the advantages and (some) disadvantages of the corpora mentioned above, it is clear that research into other ethnic traditions necessitates compiling new databases, a task which was accomplished within the framework of this research project. This raises the question of specific requirements and issues that should be taken into account when compiling a corpus of folk music adequate to the tasks of a particular study.

An ideal corpus should have at least three important qualities – it should be *informative*, *reliable* and *voluminous* enough to obtain statistically significant results. It seems that building such a corpus of traditional music is much more time-consuming than building a corpus of classical or popular music. Although it would be relatively easy to compile a corpus of sound recordings (especially archival ones), the audio corpora allow the researcher to investigate a limited range of specific issues and are not suitable for in-depth structural music analysis, which is the goal of the present study. For this last purpose the musical transcriptions (usually using Western staff notation) are far more informative. However, this raises the question of the reliability of the transcriptions themselves. A critical analysis of the sources often shows that what might be called 'historical' notations (for example, those made in the first half of the 20th century and earlier) should be treated with great caution. The degree of reliability of musical transcriptions of folk music, especially relatively early ones, depends on the degree of complexity and peculiarity of the musical style, with the result that ancient traditional music, using special scales, microalterations and specific rhythms, is often notated with significant distortions by researchers accustomed to the Western European musical system.[7] In

HURON, *The Melodic Arch in Western folksongs*; AARDEN – HURON, *Mapping European Folksong*; SHANAHAN – HURON, *Interval Size and Phrase Position*; LÈVEILLÈ GAUVIN *et al.*, *On the Role of Semitone Intervals*.

4. EEROLA – TOIVIAINEN, *Digital Archive of Finnish Folk Tunes*.
5. See SHANAHAN – SHANAHAN, *The Densmore Collection*; SHANAHAN *et al.*, *Mining Musical traits of Social Functions*.
6. *ETHNOMUSE: Multimedia Digital Archive*.
7. My own experience of comparing published musical transcriptions of Seto multipart

general, there is a tendency for later transcriptions to be more reliable, and the inclusion of original sound recordings in the corpus is desirable to verify the notations.

The requirements of informativeness and reliability with regard to transcriptions of polyphonic music have additional specificity. The vast majority of published notations of polyphonic songs are made on the basis of single-channel recordings, which display resultant harmonic sonorities, but which do not make it possible to trace the movement of individual voices. This problem is not so acute when each textural part is performed by only one singer, but if, as is often the case, a vocal part is performed by several singers with heterophonic deviations from unison, or individual voices move more or less freely within the boundaries of the polyphonic texture, then a multichannel recording method, where each singer is recorded on a separate microphone, is absolutely essential if we are to understand the structure of the polyphony. The musical material of the present study consists of multichannel (mostly 6-8-channel) sound recordings of Moksha songs from 2015-2020, collected and notated by the author of this article, and Nikolay Boyarkin's score notations based on multi-microphone recordings from the 1970s.[8] The ethnomusicologist therefore needs to do a great deal of work – to complete the musical transcription of a large amount of multichannel sound recordings and to encode these transcriptions into a programme-readable format. It would certainly be wonderful to be able to facilitate this task by using automatic notation of sound recordings, but it seems that this technology does not work well as yet, especially in the case of multipart music.

In addition to the informativeness and reliability of the corpus, there is also the question of its volume. In this respect, traditional music research also has its own specifics. To obtain statistically significant results, large and diverse corpora are certainly preferable; local folk music traditions, however, are mostly quite small in terms of both the repertoire of tunes and the amount of recorded material. The number of different tunes in one tradition is practically never in the thousands. Moreover, if the task is to describe a particular style, for which corpus analysis offers special possibilities, then a stylistically homogeneous corpus should be compiled, i.e. the existing materials relating to the tradition under study should be used only in part or sub-corpora should be compared with each other. It seems, however, that depending on the precise research question, small corpora of local musical traditions can be quite effective, and in any case they allow us to obtain data that would be inaccessible using a manual approach.[9]

songs (south-eastern Estonia) with archival sound recordings has revealed significant discrepancies in the interpretation of musical scales by the transcribers, which makes many publications of Seto songs unsuitable for a reliable description of this musical style (PÄRTLAS, *Setu Multipart Singing*).

8. BOYARKIN, *Pamyatniki*, Vols. 1 and 2.
9. As Marsden noted, «Corpus studies of music involve research with large bodies of music, but it is not quantity of data which is the distinguishing feature of this kind of musicology» (MARSDEN, *Reliability and Validity*).

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The above consideration also applies to the corpus that underlies the present study. Since the aim of the analysis is to describe the early style of Moksha multipart songs based on the pentatonic scale, I limited the corpus to pentatonic songs, excluding diatonic songs, which belong to a later, Russian influenced stylistic layer. In the available materials I was able to find 58 performances of pentatonic Moksha songs which were presented in multichannel sound recordings and/or score notations. From each performance only the first three melostrophes were used, since subsequent variants usually begin to repeat themselves (the corpus consists of 173 strophes). Considering that each melostrophe represents from three to ten individual voice parts, the total number of individual tune variants analysed is about 1150.

2. The Moksha Multipart Singing Tradition

The Moksha are one of two Finno-Ugric peoples living in the Volga-Ural region of Russia, mostly in the Republic of Mordovia and commonly referred to by the exonym Mordvins (the second people belonging to the Mordvins is the Erzya). Both the Moksha and the Erzya are known for their rich tradition of multipart singing, which is quite unusual among Finno-Ugric peoples, whose singing is mostly monophonic. They have several types of multipart singing, of which some are of very ancient origin.

This research is dedicated to the old Moksha multipart style which the Mordovian ethnomusicologist Nikolai Boyarkin defines as *drone two- and three-part singing*.[10] In this style, singers are divided into two or three textural parts, of which the lower and/or the upper subsidiary parts are built around one scale note (the tonic and the fifth above the tonic). The latter technique imparts to the whole some of the features of a drone polyphony, although it would be more precise to name this texture 'drone-like'. The main part – in the three-part songs, the middle voice – is named by Moksha singers *mora vaigyal'* (voice of the song); the native terms for the drone-like subsidiary parts are *alu vaigyal'* (lower voice) and *vyari vaigyal'* (upper voice). All the parts are usually performed by several singers in a heterophonic manner with a considerable degree of variation. Over the last about 50 years this singing style has undergone some modification; the most notable change is the addition of one more part – the drone-like solo upper part (on the octave above the tonic) – to which singers refer using the Russian folk term *podgolosok* (subsidiary voice).[11] An example of a four-part performance with *podgolosok* is given in Example 1; the names of the voice parts are written in the score, however, it is easy to see that each singer's interpretation is quite individual. The most developed forms of this style occur in the lyrical and epic songs with longer tunes; this type of singing is also characteristic of wedding songs.

10. BOYARKIN, *Pamyatniki*, Vol. 2, pp. 12, 13-20
11. PÄRTLAS, *The Moksha Mordovian Multipart Songs*, pp. 125-126

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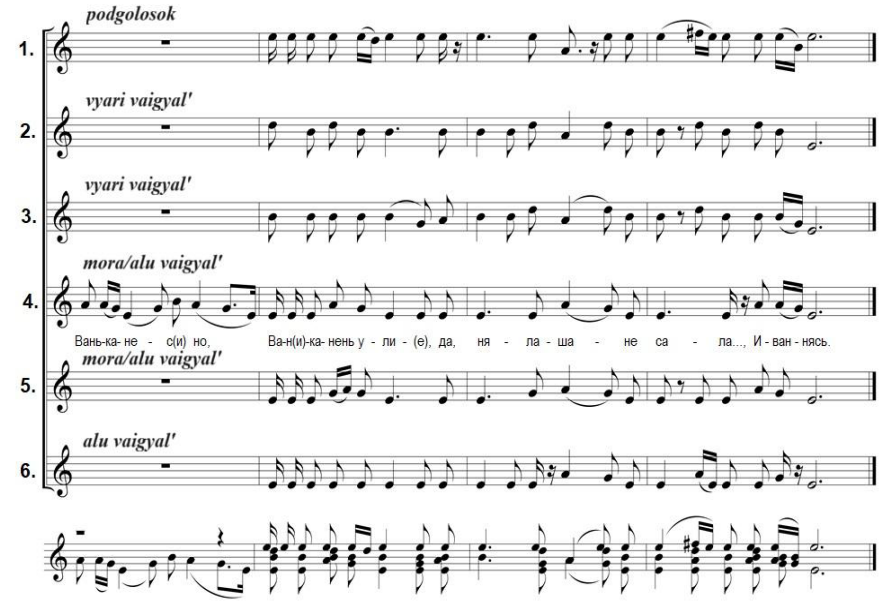
Example 1. The lyrical song *Саразонь Керьгонь Ваньканесь*, recorded in 2017 in Sire Terizmorga village (notation by Žanna Pärtlas)



The song tunes in the style studied here are generally based on the pentatonic scale of a wider range, which can be notated using the American Standard Pitch Notation as D4-E4-G4-A4-B4-D5-E5-(F♯5) (see Example 1). The note F♯5 does not belong to the pentatonic scale, but it is used only in the upper solo voice (*podgolosok*) and occurs in the recent sound recordings (2015-2020). From the point of view of the present analysis, it is important that in the Moksha pentatonic songs the 'tonic' (modal centre and final tone) may be on E4 or D4, which divides the songs in the modal terms into two groups which I will conventionally call tunes 'in E' and 'in D' (the song provided in the Example 1 is 'in E'). It is reasonable to assume that in these two variants of pentatonic mode the functions of the scale notes and the principles of formation of harmonic sonorities may differ. Therefore, when compiling sub-corpora for comparative analysis, this feature was also taken into account. Apart from the notes of the pentatonic scale, in real performances some diatonic notes sometimes also occur – occasionally C5 and very rarely F4, F♯4, C♯5, etc. The appearance of the note C5 is presumably connected with the influence of the Russian diatonic song style (Moksha singers sing the Russian repertoire very well); the other diatonic notes belong to the accidents of performance.

Hypotheses and Research Method

The purpose of using corpus analysis in this study is to obtain more accurate, detailed and objective information about the harmonic structure of Moksha

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pentatonic multipart songs and to describe the changes that have occurred in this style between the 1970s and 2020. Throughout the project, other aspects of musical structure have been analysed using the corpus method (e.g. the sequences of scale notes and their metric positions); however, here we will limit ourselves to questions of harmony, as this is a specific aspect of polyphonic music and a very distinctive feature of the Moksha old style. Moreover, the analysis of harmony will be focussed here on the use of individual vertical sonorities and harmonic intervals, their constituent scale notes and acoustical properties, while the study of harmonic sequences will be left aside for the time being, despite the importance of this aspect.[12]

With the help of statistical analysis of the occurrence of full harmonic sonorities and intervals between pairs of voices in different sub-corpora, I intend to test some hypotheses that have been raised previously in studies of Moksha polyphony and which have emerged in my own research of Moksha songs using conventional analytical methods. Firstly, when listening to Moksha songs, one notices their 'dissonant' sound, which results from the abundance of harmonic sonorities containing seconds and sevenths.[13] I would like to quantify this observation and check whether these properties of the harmony of Moksha songs have changed over the period under study. Secondly, the analysis of the scores gives the impression that the musical thinking of Moksha singers is predominantly melodic, which leads to the great spontaneity of the harmonic vertical. In this respect, it would be interesting to differentiate between structural and accidental (i.e. resultant) vertical sonorities, which would enable us to test the correlation between the melodic and harmonic logic in the formation of melodic variants in the individual parts. Finally, the third task is to test quantitatively the hypothesis of polyphony 'with a fifth frame',[14] which means that the perfect fifth is the main harmonic reference interval in Moksha multipart songs. This feature of the Moksha style would be interesting to test using the corpus method because although the texture of the songs contains two drone-like parts on the tonic and the modal fifth (*alu vaigyal'* and *vyari vaigyal'*), the individual voices, especially those belonging to the *vyari vaigyal'*, can be quite mobile and it is difficult to estimate without statistical calculations as to the extent to which the perfect fifth drone actually occurs in the songs.

12. There are two reasons for such limitation of topic. Firstly, the study of individual harmonic sonorities, as will be shown later, provides sufficiently revealing results and possibilities of their interpretation to be presented within a single article. Secondly, the study of harmonic sequences by means of corpus analysis is methodologically problematic, since in the conditions of melodic type of polyphony and the abundance of non-structural notes in individual melodic variants, functionally related structural sonorities (chords) are unlikely to follow each other directly. We also do not consider the relationship between the content and articulation of the verbal texts of the songs and their harmonic structure, since in Mordovian songs, as in most ancient oral song traditions, such a relationship is absent. The connection between verbal and musical structure could be observed in the tune form, but it is beyond the scope of this article to study this aspect.
13. BOYARKIN, *Pamyatniki*, Vol. 2, p. 16; BOYARKINA, *K probleme izucheniya*, p. 213.
14. BOYARKIN, *Pamyatniki*, Vol. 2, pp. 14-15; BOYARKINA, *K probleme izucheniya*, p. 214

The codes used in the present analysis were developed on the basis of *music21*, a toolkit for computer-aided musicology created by Michael Scott Cuthbert from the Massachusetts Institute of Technology.[15] Analytical procedures were applied both to the entire corpus and to some of its constituent parts – to songs from the older and newer collections and to songs with two different types of pentatonic mode. Altogether, nine groups were compared.

3. Analysis of the Harmonic Sonorities

In the whole corpus 188 different harmonic sonorities were found.[16] Such a large number can be explained partly by the fact that all the vertical slices of multipart texture were taken into account, including random and very rare ones, and partly because we are dealing here with a wide-range scale consisting of seven basic pentatonic scale notes,[17] to which several diatonic notes are added (the use of the latter is statistically insignificant, but nevertheless the programme registers them as well). To reduce the 'noise' in the data, I first removed harmonic sonorities containing random notes not belonging to the pentatonic scale, but even after that, the number of harmonic verticals (including very rare ones) remained too large to analyse. Then I summarised the same sonorities with and without the addition of the upper tonic (E5), because the drone on the upper tonic (*podgolosok*), which modern Moksha singers add to the texture, is not an obligatory element of performance; this reduced the number of sonorities analysed to 58. The data on unisons, which in Moksha songs are mostly limited to the extended unisons at the end of the strophe, have also been removed. Diagram 1 presents data on the occurrence of full harmonic sonorities in the whole corpus; for practical reasons, the data in the diagram are limited to the first 36 sonorities (the verticals that do not appear in the diagram occur in less than 0.5% of cases).

The first thing to note in Diagram 1 is its characteristic shape, with a sharp downward slope at the beginning and a long flat 'tail' further on. This indicates that some harmonic sonorities are clearly favoured, while others are rare and almost equally infrequent. In line with our expectations, it turned out that the perfect fifth E4-B4, with or without the addition of the upper tonic E5, predominates by a large margin, pointing to the validity of the hypothesis of polyphony 'with a fifth frame'. The fifth is followed by the third G4-B4, and in the next place is the sonority E4-A4-B4, where A4 is added to the fifth E4-B4, forming the second A4-B4. The latter sonority also draws the listener's attention in Moksha pentatonic songs, giving their sound a sharp 'dissonant'

15. CUTHBERT – ARIZA, *music21*. See Acknowledgments.
16. Under 'harmonic sonorities' we mean here all harmonic verticals which occur in the texture irrespective of their structural status. They could be called 'chords' shortly, but the term 'chord' rather designates a vertical sonority which has a regular structure appropriate to a given style and a meaning as a concept of harmonic thinking.
17. We treat the repetitions of notes in the upper octave as separate scale notes.

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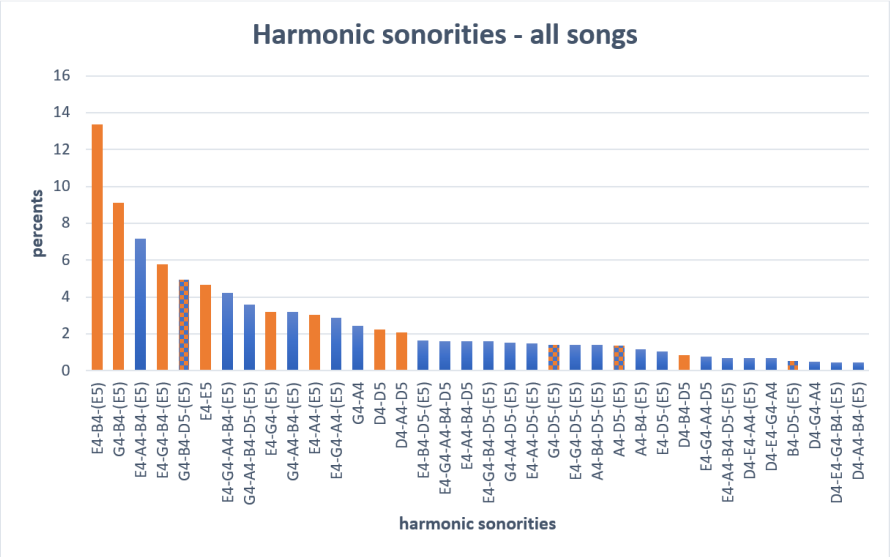

Diagram 1. Harmonic sonorities in the whole corpus

timbre. It is no accident that all three of the above-mentioned preferred sonorities contain the scale note B4; this scale note actually appears in all the eight most frequent sonorities apart from the octave E4-E5, which in our material is found almost exclusively in recordings of the 21st century.[18]

To describe the harmonic sound of Moksha pentatonic songs, I used the conventional division of harmonic sonorities into 'consonant' and 'dissonant', referring to the acoustic and psycho-physiological properties of harmonic intervals (such as 'beating' and 'roughness') and leaving aside the vast topic of perception, meanings and aesthetic evaluation of intervals in different cultures.[19] In the case of the Moksha pentatonic scale, according to this theoretical premise, only the major seconds (D4-E4, G4-A4, A4-B4 and D5-E5), the minor seventh E4-D5 and the major ninth D4-E5 were considered dissonant; the other intervals were classified as consonant.[20] In Diagram 1, harmonic sonorities containing dissonances are shown in blue and those that are fully consonant are shown in orange; both colours are used in cases where a sonority becomes dissonant only when the scale note E5 is added (i.e. when there is the *podgolosok* in the performance). The diagram shows that among the more

18. An analysis of the occurrence of individual scale notes, which is not presented in this article, reveals that the scale note B4 predominates both in the whole corpus and in all sub-corpora, with the exception of the tunes in D.
19. Many studies suggest that there is a culture-independent psycho-physiological component in people's perception of the acoustic properties of musical intervals (see e.g. MILNE *et al.*, *Evidence for a Universal Association*; TRULLA *et al.*, *Computational Approach*). Among the intervals under consideration in this article, major seconds have the greatest auditory roughness (VASSILAKIS, *Auditory Roughness*, p. 132).
20. This paper does not take into account the exact size of the intervals (the tuning type), as this does not affect the results of the corpus analysis. It would be interesting to conduct a separate acoustic study on this topic in the future.

frequently occurring sonorities, consonances predominate (among these, the three sonorities E4-B4-(E5), G4-B4-(E5) and E4-G4-B4-(E5) are strongly favoured), although there are also some dissonant structures with relatively high occurrence rates (notably, E4-A4-B4-(E5), E4-G4-A4-B4-(E5) and G4-A4-B4-D5-(E5)). Among the rarer sonorities, which vary little in frequency of use, dissonances predominate. In general, consonant harmonic verticals account for about 55% of all the harmonic sonorities encountered.

The above analyses suggest that the structural basis of Moksha polyphony is formed by certain consonant sonorities, although singers do not avoid dissonances, so that quite often (almost) all scale notes can sound simultaneously as clusters. The extremely large number of registered harmonic sonorities, including those whose frequency of use differs little, gives grounds to believe that the hypothesis concerning the melodic nature of the Moksha singers' musical thinking is true, i.e. when forming their melodic variants, they do not consciously plan the achievement of specific harmonic sonorities. However, we can assume the existence of certain consonant reference intervals (especially the perfect fifth E4-B4), the reliance on which on the part of the singers leads to the more frequent formation of some sonorities.

Interesting results are obtained by comparing the recordings from the 1970s (Boyarkin's collection, which we call here the 'old collection') and from 2015-2020 (the 'new collection'). Diagrams 2 and 3, representing the old and new collections, follow the same principle as Diagram 1.[21]

The difference between the diagrams for the old and new collections is very apparent even at first sight. Starting with the colour designations of consonant and dissonant sonorities, it is striking that in the diagram of the old collection (Diagram 2) blue predominates, indicating dissonant sonorities, whereas in the first third of the diagram of the new collection (Diagram 3) orange strongly predominates, indicating consonant verticals. The curve of the diagrams also differs noticeably – in the performances of 2015-2020 we find an extraordinary predominance of one harmonic sonority, E4-B4-E5, over all others, whereas in the 1970s collection the decrease in the occurrence of sonorities is much smoother. Comparison of both diagrams with the general diagram of the whole corpus (Diagram 1) demonstrates that even when analysing one style layer of a local ethnic tradition, the total corpus can hide quite different musical systems with their different patterns.

In contrast to the general results for the whole corpus, which basically confirm our previous intuitive assumptions, the separate results for the old and new collections are in many respects unexpected and even counter-intuitive, although it is still possible to find explanations for them. In the results for the old collection it is surprising that in first place in the occurrence of sonorities is the third G4-B4, rather than the fifth E4-B4 that is so noticeable in the auditory perception of Moksha songs. It is also somewhat unexpected that the dissonant sonority E4-A4-B4 has risen to second place here. In the new

21. The difference is that in Diagrams 2 and 3 there is no need to combine sonorities with and without the scale note E5.

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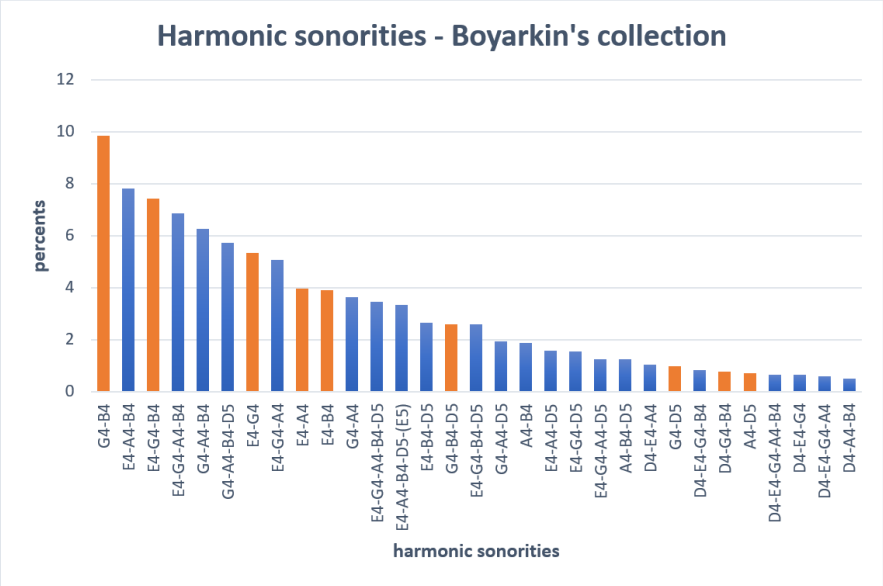

Diagram 2. Harmonic sonorities in the collection of the 1970s

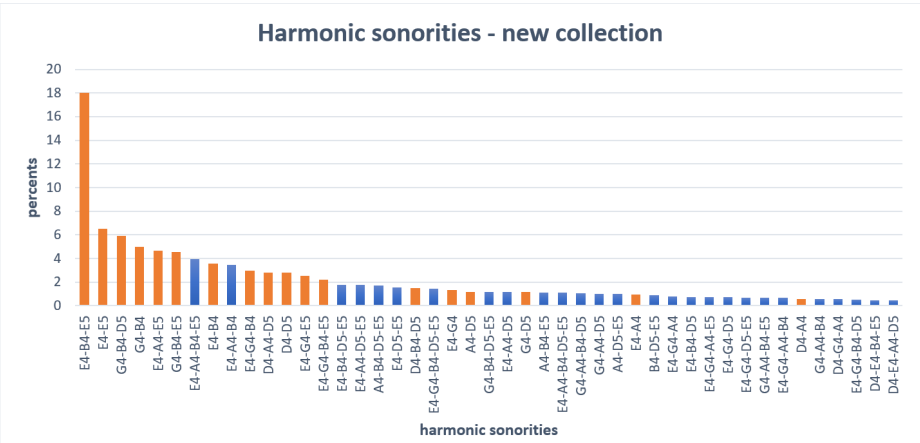

Diagram 3. Harmonic sonorities in the collection of 2015-2020

collection it is counter-intuitive for me to find such a significant predominance of consonant sonorities, as in my perception of the Moksha style, even in its late version, it is the dissonant harmonies that impart to the sound of the songs its originality and energy. However, if in the diagram of the new collection we group together the results for the sonorities E4-A4-B4-E5 and E4-A4-B4, which are essentially varieties of the same harmonic complex, this structure would rise to second place, alleviating to some extent the perceptual contradiction, though it would not eliminate the unexpected fact that the other dissonances are relatively rare. The difference between the overall results for consonant and dissonant harmony in the old and new collections is

especially striking – in the former, consonant verticals are in a clear minority, accounting for 35.5% of the cases, while in the latter they are in a clear majority, accounting for 68.1%.

What changes in the style of the Moksha songs lie behind the results of computer analyses of the old and new collections? This question can be answered on the basis of conventional musical analyses of scores and field observations. The main reason behind the changes lies in the intensity of melodic variation and the structure of melodic variants. In Boyarkin's scores the individual parts vary far more than in recent performances. There are few unisons within the polyphonic parts (i.e. the parts are largely heterophonic) and the melodic variants themselves contain more embellishments. The greater melodic variation of the older style leads to the formation of more non-structural sonorities, which often turn out to be dissonant. This explains the significant prevalence of dissonances in the old Moksha style (64.5% of sonorities contain seconds and sevenths). In 21st century performances, melodic variation has decreased and the variations have become simpler. As a result, referential intervals and structural sonorities, which, according to the diagrams, in Moksha polyphony are mostly consonant, come into the foreground, i.e. the simplification of the polyphonic style has exposed the consonant basis of Moksha harmony, as the referential intervals are more often realised in sound.

The second reason for the changes in the harmonic characteristics of Moksha songs is the tendency that I noticed both by talking to singers during field work and in my notations of sound recordings. Namely, with the appearance of an additional upper part (*podgolosok*), the main part (*mora vaigyal'*) and the lower drone-like part (*alu vaigyal'*) converged and even merged, and both partially lost their original function. This caused the *mora vaigyal'* part to move lower and to make less use of the trichord G4-A4-B4, which was very important in the melodic variants of the old style. The *alu vaigyal'* part in turn became less drone-like. In conversations, singers often made no distinction between *mora vaigyal'* and *alu vaigyal'*, referring instead to the 'second voice'. They began to call the *vyari vaigyal'* part 'the first voice', but its function and the type of melodic variants had not changed since Boyarkin's expeditions. It seems that it is the active use of G4-A4-B4 notes in the variants of the main part that leads to the formation of many dissonant sonorities in the old style, including clusters of seconds.

It is also interesting to compare the sub-corpora of tunes of different modal types – the above-mentioned tunes in E and in D. This allows us to better understand the modal system of the Moksha pentatonic style and even shed light on its history. The results for these two sub-corpora are given in Diagrams 4 and 5.

Diagrams 4 and 5 clearly demonstrate the differences in the harmonic characteristics of tunes in E and in D. In both cases the most preferred sonorities are consonant, but in the tunes in E the total number of consonant sonorities is 49.4%, while in the tunes in D it is 57.9%, i.e. the harmony of the latter is more consonant. The most frequent dissonant structure in both cases

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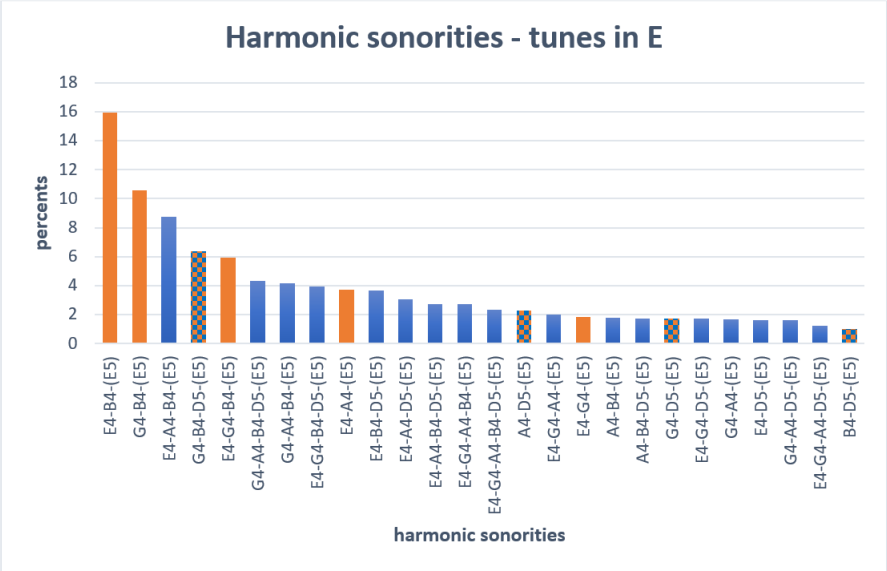

Diagram 4. Harmonic sonorities in the tunes in E

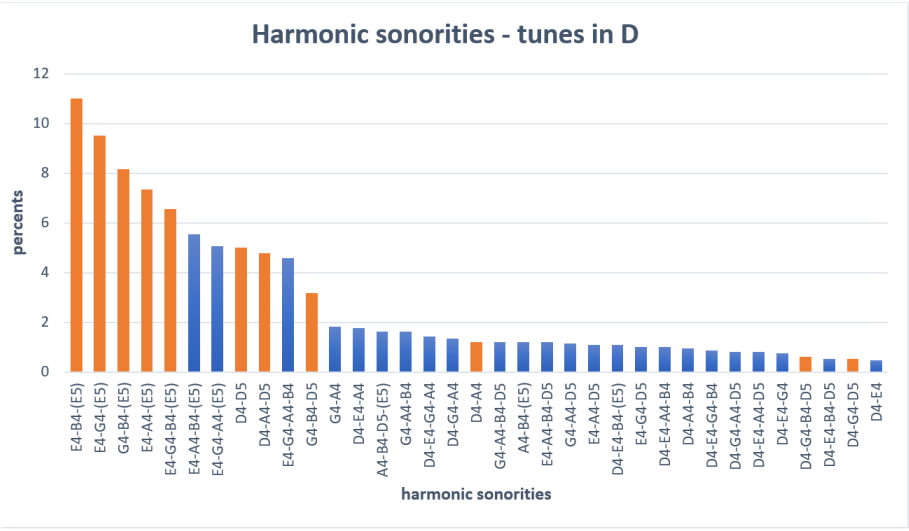

Diagram 5. Harmonic sonorities in the tunes in D

is the same – the sonority E4-A4-B4-(E5),[22] whose predominance over other dissonances is also revealed at the level of the whole corpus (see Diagram 1). However, in the tunes in E the rate of this sonority is 8.7%, while in the tunes in D it is 5.5%, which also indicates that the latter are somewhat less dissonant. There is also a difference in intervals with high occurrence: for example, in tunes in D the value of the third E4-G4 (9.5%), which is the second most

22. For brevity, the possibility of adding a drone on E5 to (almost) any harmonic structure in the new style will not be mentioned further.

common sonority here, is much higher - in tunes in E this sonority is in 17th place, accounting for only 1.8% of cases.[23] The specific weight of the dissonant sonority E4-G4-A4 is also different – in the tunes in D it is the second most frequent (5.1%), while in the tunes in E it is in 16th place (2%).

Further examples of differences could be given, and a detailed analysis of the scores could clearly explain the reasons for them. However, in the results for songs based on the two varieties of the Moksha pentatonic mode, what is unexpected is not so much the differences as the similarities. Based on the logic of these modes and the harmonic principle of the 'the fifth frame', it would be reasonable to assume that if in tunes in E the fifth E4-B4 is very important, then in tunes in D the fifth D4-A4 should be of great importance. One might also predict that in tunes in D sonorities involving D4 would predominate over sonorities involving E4. However, analyses of the two corpora reveal that the sonority E4-B4 is the most common in both tunes in E and tunes in D (16% and 11% respectively). If we consider also more complex sonorities containing the fifth E4-B4, we find that in tunes in D this interval occurs in 31.4% of cases and in tunes in E in 43.2%. At the same time, the fifth on the tonic D4-A4 is found in tunes in D in a pure form only in 1.2% of cases, and as an element of different sonorities in 14.1%. As for the tonic D4 itself, in tunes in D it is a part of 22.9% of sonorities, while the scale notes E4 are found in the same songs in 61.6% of sonorities (that is, about as often as in the songs where it is a tonic – in 60% of cases).[24]

Some conclusions can be drawn from the above data. First, it can be argued that the modes with a tonic on E and D (the modes E and D) are not equal in this tradition. It seems that the mode E is the primary and basic structure of the Moksha pentatonic style, and the mode D emerged historically later, but without losing some of the features of the mode E (we are talking here about rather old processes of repertoire formation, since the ratio of songs in E and in D in the two collections analysed is approximately equal). The assumption of the primordiality of the mode E is based on the fact that in tunes in D the scale note E4 and the fifth E4-B4 occur much more often than the note D4 and the fifth D4-A4. Listening to and analysing songs in D, one can notice that the middle sections of the melostrophe are often based on the mode E, and the note D4 shows itself as a tonic mostly in the initial and cadential phrases. This hypothesis is also supported by the fact that pentatonic wedding songs, which are an earlier genre than lyrical and narrative songs, are all based on the mode E.

Summarising the data of all the diagrams given in this section of the article, we may also note that although all the diagrams clearly show the presence of preferred harmonic sonorities, and the difference between the occurrence of individual sonorities can be very large, the number of sonorities with relatively low and very low occurrence is quite high (they do not even all fit into

23. It should be noted here, however, that the third E4-G4 may be a part of other sonorities. The use of individual intervals will be discussed in the next section of this article.

24. In the songs in E, scale note D is so rare that it is not represented in Diagram 4.

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the diagrams) and their cumulative percentage is considerable. This is another argument in favour of the melodic nature of the Moksha singers' musical thinking, which leads to the formation of a large number of non-structural, mostly dissonant, sonorities.

4. Analysis of the Harmonic Intervals Between Pairs of Voices

As is evident from the previous section of the article, statistical analysis of the occurrence of harmonic sonorities gives quite meaningful results in the case of Moksha pentatonic songs – it allows us to describe the main characteristics of the song's harmony, to trace the development of the tradition in the period under study, and to discover the relationship between the two forms of the Moksha pentatonic mode. In addition to full harmonic sonorities, the formation of individual harmonic intervals between pairs of voices was also analysed (i.e. this time the score was not 'chordified'). This analytical procedure was undertaken for two reasons. Firstly, statistics on the use of individual intervals can provide additional information, since it is quite likely that when coordinating the voices with each other, singers focus on pairwise correspondences rather than on the full sonority, which is difficult to predict in view of the great variation in the voice parts. Secondly, in terms of the sound effect of polyphony, it is important how many singers sing one note at a time. The analysis of the use of intervals largely confirmed the observations and conclusions obtained through the analysis of full sonorities, so I will describe the results only briefly.

Following the plan of the previous section, we begin with a diagram showing the use of intervals between pairs of voices in the full corpus (Diagram 6). To refine the information about intervals, we have added the division of consonances into perfect and imperfect, according to the division adopted in Western European music theory (perfect consonances are marked in blue, imperfect consonances in orange, and dissonances in purple). Since only 21 different intervals are possible between the seven scale notes of the Moksha pentatonic scale, the results of the analysis did not have to be reduced as in the case of complete sonorities.

Diagram 6 is quite consistent with Diagram 1 – both begin with the fifth E4-B4 and the third G4-B4. The first dissonant interval, A4-B4, ranks fifth in Diagram 6, while the sonority with this interval, E4-A4-B4, ranks third in Diagram 1. The rarest dissonant intervals are the second or ninth D-E. Intervals involving the note D4 are at the end of the diagram, as this scale note is only present in songs in D, and even there in rather small numbers. Diagram 6 shows more clearly than the diagrams of complete sonorities that consonant intervals between individual voices predominate over dissonant intervals, with perfect consonances predominating over imperfect ones. This indicates that the numerous dissonant full sonorities we saw in Diagrams 1-5 may be

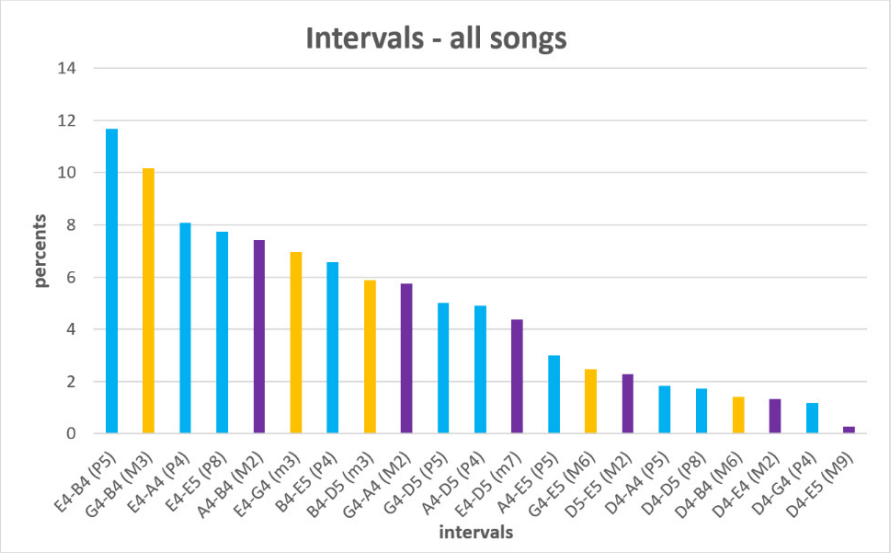

Diagram 6. Harmonic intervals in the whole corpus

the result of the melodic variations of individual singers, while most singers are simultaneously forming consonances.

Comparison of the old and new collections (Diagrams 7 and 8), as well as the corresponding diagrams of full sonorities, show great changes in style. Performances recorded in the 1970s are significantly more dissonant than 21st century recordings. Moreover, in the older collection, dissonances are numerous at the level of pairs of voices, suggesting that many of the singers were involved in the formation of dissonances. Diagram 7 has a step-like shape, and information can be deduced from this too. The first six intervals use the notes of the tetrachord E4-G4-A4-B4, which means that in the old style most individual parts moved in the diapason that correspond to the main heterophonic part *mora vaigyal'*. The next 'step' consists of four intervals which are formed with scale note D5, which in the old style is found only in the upper drone-like part *vyari vaigyal'*. This is followed by four intervals including scale note D4, which obviously originate from songs in D. The last, very rare intervals are almost all associated with the upper tonic E5, which is nearly non-existent in performances of the old collection.

In the songs of the new collection (Diagram 8), predominantly consonant intervals are formed between individual voices, from which we can conclude that dissonant harmonic verticals are produced in the new style as a result of individual melodic variants. Changes in the ratio of occurrence of the three most characteristic dissonances – seconds A4-B4 and G4-A4 and seventh E4-D5 – are also indicative. While in the songs of the old collection the occurrence rates of these intervals are 11.5%, 10.8% and 5% respectively, in the new collection their rates are (in the same order) 4.8%, 2.5% and 4%. In addition to the marked overall decrease in the occurrence of dissonant intervals in the new style, it is noteworthy that while in the old collection there is little differ-

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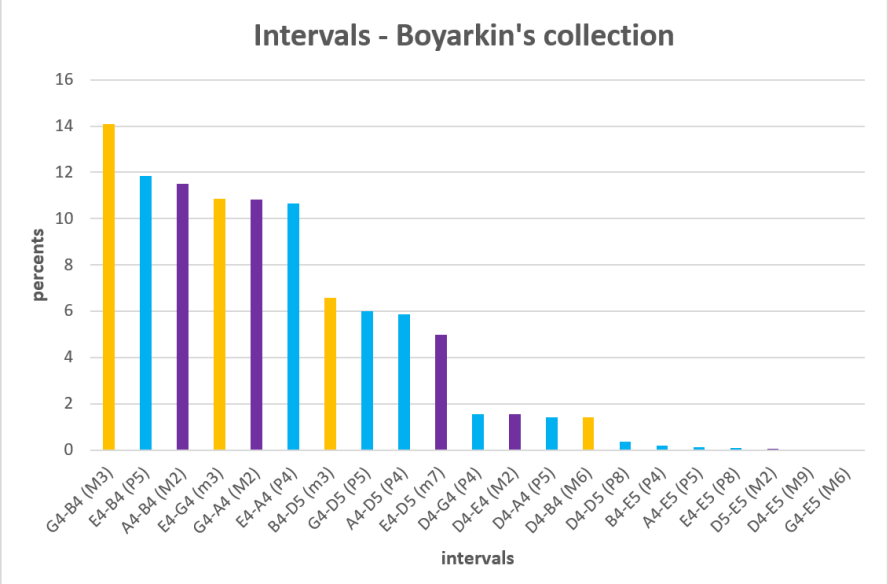

Diagram 7. Harmonic intervals in the collection of the 1970s

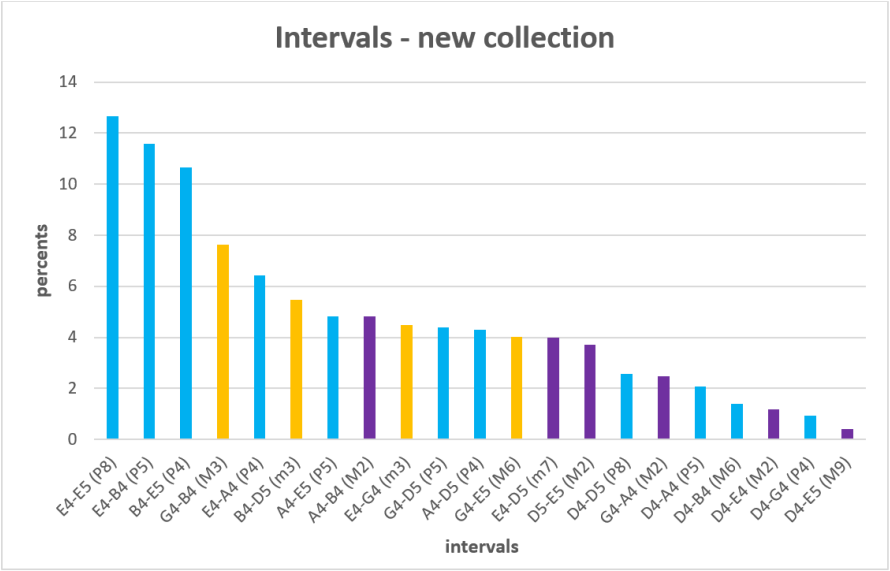

Diagram 8. Harmonic intervals in the collection of 2015-2020

ence between the use of the seconds A4-B4 and G4-A4, in the new collection the occurrence of the second G4-A4 is much lower. This also suggests that the singers make little use of the middle part of the scale and that the importance of the *mora vaigyal'* part, which was the main part in the old style, has diminished.

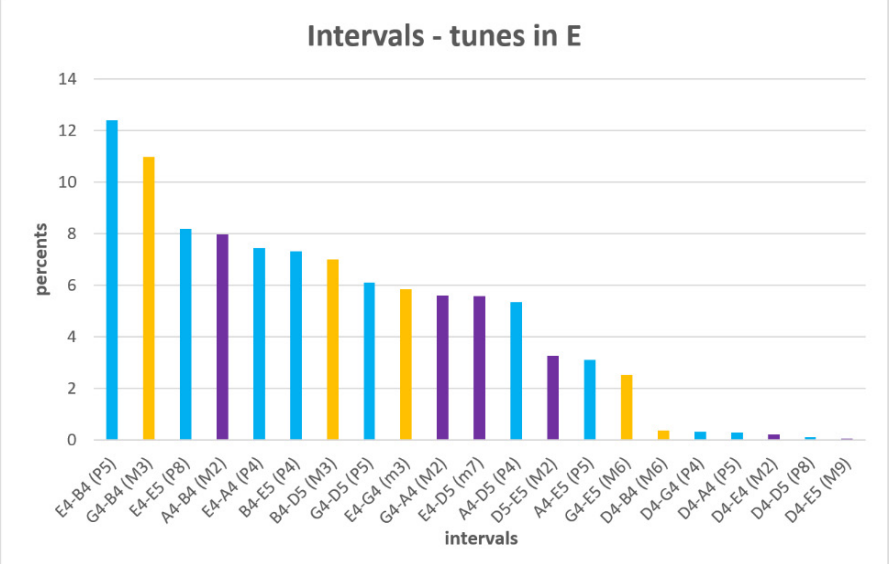

Diagram 9. Harmonic intervals in the tunes in E

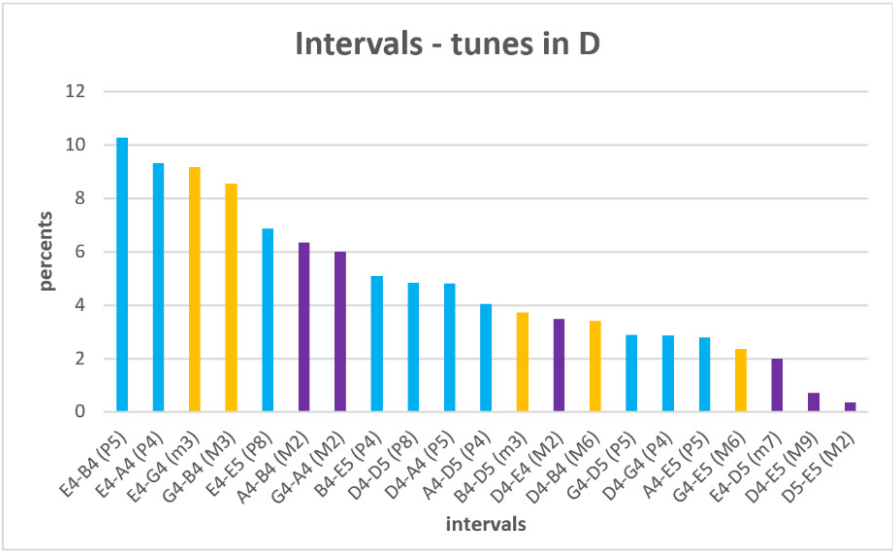

Diagram 10. Harmonic intervals in the tunes in D

The last pair of sub-corpora that are compared in this article represent tunes in E and in D (Diagrams 9 and 10). The diagrams for these two sub-corpora show the difference in harmonic structure, which is manifested in a significant change in the occurrence of certain intervals. For example, the third E4-G4 is in ninth place (5.8%) in the tunes in E and in third place (9.2%) in the tunes in D; the fourth E4-A4 is in fifth place (7.5%) in the tunes in E and in second place (9.3%) in the tunes in D, etc.

These and other differences can be explained by analysing the scores, but, as has already been noted on the basis of our analysis of the complete sonorities, the songs in D unexpectedly reveal many features inherent in the mode E: the fifth E4-B4 is the interval most used in both types of tunes, the three most frequent intervals of tunes in D have E4 as their lower note, while the tonic D4 appears in them only from the ninth in frequency interval, etc. All this confirms the assumption about the primacy of the mode with the tonic on E4 in Moksha pentatonic songs.

The analysis of the full harmonic sonorities in the previous section of the article suggests that songs in mode E are more dissonant than those in mode D. The number of dissonant and consonant verticals in tunes in E was found to be approximately equal, 50.6% and 49.4%, while in tunes in D these figures are 42.1% and 57.9%, respectively. Comparing these results with the data on intervals between pairs of voices, we find that here the difference between the two types of pentatonic mode levels out somewhat – in tunes in E dissonances account for 22.7% and consonances for 77.3%, whereas in tunes in D these figures are 18.9% and 81.1%. A comparison of the two sub-corpora with respect to the use of perfect and imperfect consonances yields only slightly different results (see Table 1).

Table 1. *The proportion of three kinds of intervals: perfect consonances, imperfect consonances and dissonances*

(PERCENT)	FULL CORPUS	OLD COLLECTION	NEW COLLECTION	TUNES IN E	TUNES IN D
PERFECT CONSONANCES	51.7	38.1	60.4	50.6	53.9
IMPERFECT CONSONANCES	26.9	32.9	23	26.7	27.2
DISSONANCES	21.4	29	16.6	22.7	18.9

We should also check whether the ratio of the three categories of intervals (perfect and imperfect consonances and dissonances) might not be determined by the number of intervals of these categories in the Moksha scale. If all possible 21 intervals are counted, then if they were used equally (i.e. without any preferences), the proportion of perfect consonances would be 47.6%, imperfect consonances 23.8%, and dissonances 28.6%. The results for the full corpus and all sub-corpora are summarised in Table 1.

In the whole corpus and in the sub-corpora for tunes in E and in D, the number of perfect consonances between pairs of voices is somewhat higher than it would be in the absence of preferences; it is much higher in the songs of the new collection, and noticeably lower in those of the old collection. The ratio of imperfect consonances and dissonances is everywhere opposite to the 'predicted' one – although more dissonances than imperfect consonances can

be formed between the notes of the Moksha scale, in all five corpora the latter prevail over the former. The results for the old and new collections differ most of all. Whereas in the old collection the differences between the weight of different types of intervals are smallest, which is evidence of the melodic nature of the tune variation, in the new collection we see a significant over-preponderance of perfect consonances and the smallest number of dissonances.

5. Conclusions

Summarising the findings of this corpus analysis of Moksha multipart pentatonic songs, the following conclusions can be drawn:

1. The analysis reveals that Moksha pentatonic songs have very dissonant (at least from the psycho-acoustic point of view) harmony, which confirms our prior auditory and analytical observations. Among all the full sonorities considered, almost half contain seconds and sevenths. This feature is very pronounced in the recordings of the 1970s (64.5% of dissonances) but is drastically reduced in the recent recordings (31.9% of dissonances).

2. Harmonic sonorities – both full sonorities and individual intervals – have a clear hierarchy in their use, suggesting the existence of reference harmonic structures in the musical thinking of the Moksha singers. Analysis of all the (sub-)corpora reveals that certain consonant verticals predominate among the most frequent sonorities, which suggests that Moksha pentatonic polyphony has a consonant structural basis. One of the most important intervals in both the older and newer recordings is the perfect fifth on the modal tonic (E4-B4), which confirms the hypothesis of polyphony 'with a fifth frame'.

3. The most characteristic dissonant sonority of the Moksha pentatonic style is the chord including modal tonic, fourth and fifth (E4-A4-B4).

4. Comparison of tunes with the tonic on E and D revealed noteworthy differences in their harmonic structure, which is expressed in the preference for different vertical sonorities. However, in the tunes in D, an unexpectedly high occurrence of scale note E4 and fifth E4-B4 was found; these clearly prevail over the intuitively expected 'favourites' D4 and D4-A4. This indicates the greater importance and, apparently, the primacy of the mode E in the Moksha song tradition. Songs in D also appear to be somewhat more consonant than songs in E.

5. The differences in the harmonic structure of the songs of the old and new collections are most likely related to the significant decrease in melodic variation of individual voices in recent decades. Modern performances do not contradict the foundations of the traditional style but simplify the polyphonic texture, exposing its consonant harmonic framework. Another reason for the style transformation is the changes in the relationship between the polyphon-

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ic parts. In the new style, the main voice part of Moksha songs, *mora vaigyal'*, loses its original meaning, merging with the lower drone-like part *alu vaigyal'*; this is compensated for by the addition of a new upper part (*podgolosok*).

Finally, the experiment conducted in this study on applying the method of corpus analysis to traditional vocal polyphonic music convincingly demonstrates that the corpus method is capable of producing meaningful results when analysing traditional polyphony and is a useful tool to complement conventional research methods.

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