REMARKS CONCERNING THE USE OF THE MELOGRAPH IN ETHNOMUSICOLOGICAL STUDIES*

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The Melograph, by now, has become part and parcel of ethnomusicological research and no longer needs an introduction.[1] Rather than concentrate again on its novelty and its promises, the time has come to discuss the Melograph in operation, the problems raised by the new musical material it provides, and the new methods of research it suggests. However, the scope of this article does not permit a summary of all the points which have crystallized in our minds over the years. We shall limit ourselves to some general remarks, and then dwell more specifically on an example that illustrates some unanticipated ways in which music can be examined with the aid of the Melograph. The Melograph has not only answered questions for which it was originally intended, but, as we shall discuss, the data obtained suggest new modes of analysis and concept. In Jerusalem, we have used the Melograph for the analyses of non-Western music since 1958. As is well known, Israel has become a laboratory for comparative anthropological studies of all kinds. Its inhabitants comprise Jews from many different cultural backgrounds, as well as Arab communities whose culture has remained intact. Our work hitherto has centred on an investigation of the *maqāmāt*, a study of the liturgical music of Christian Arabs in Israel, and an examination of the changes occurring in the traditional

* This article is based on studies which have been carried out in the ethnomusicological section of the Centre for Electronic Music in Israel (located at the Hebrew University, Jerusalem). The music for the examples quoted here can be obtained from the Centre. We should like to use this opportunity to thank Mr. Suhel Radwan for his invaluable assistance as liaison between us and the majority of our Arabic informants. Likewise we should like to thank Mr. Moshe Palmai for his expert supervision of our electronic set-up.

[1] A detailed review of the historical development leading to the Melograph can be found in K. Dahlback, *New Methods in Vocal Folk Music Research* (Oslo, 1958), pp. 7–8, 17; B. Nettl, *Theory and Method in Ethnomusicology* (London–New York, 1964), pp. 121–124. A technical description of the Melograph recently built in Uppsala can be found in P. A. Tove, B. Normann, L. Isaksson and J. Czekajewski, "Direct-Recording Frequency and Amplitude Meter for Analysis of Musical and Other Sonic Waveforms", in *Journal of the Acoustical Society of America*, 39 (1966): 362–371.

singing of Aleppo Jews as a result of "culture contact". We are presently engaged in a study of the music of Israeli Arabs, examining the music as a living tradition and in its historical perspective.

1. *The Melograph in the Perspective of Musical Notation*

As a rule, the notation of music does not include all the nuances and details incorporated in the music or in its performance. It represents but a technical device for purposes of communication within the framework of a well-established tradition. No matter how logical and accomplished the notation may seem, it retains an element of arbitrariness and leaves room for speculation and interpretation. This is especially evident in transcriptions and performances of music which is no longer a part of a living tradition.

Systems of notation, moreover, however adequate, may become inadequate or obsolete with a change in musical style. The shortcomings of our system of notation — a system accepted in the West for over three hundred years with relatively few modifications — have become most evident in recent years. The rise of new musical idioms, new means of musical expression and, above all, new ways for the production of musical sound call for a new system of notation or a drastic revision of the old.

The increased systematization of the study of non-European music has also drawn attention to the limitations of our system of notation. While many contemporary composers find the five-line-staff and the symbols that go with it no longer adequate, ethnomusicologists have always been at a loss in attempting to notate even the most rudimentary aspects of non-Western musical traditions. This is largely due to the fact that much of non-Western music constitutes a part of a living tradition in which communication and transmission occur orally.[2] Some theoretical conception or, at least, mental picture of the tonal relations involved is necessary, if one wishes to note them down with some measure of accuracy. In fact, all systems of notation so far incorporate a theoretical conception of the music which was written down. Of course, the assumption made here is that musical traditions contain organization of one kind or another, whether conscious in the bearers of the tradition or not.

The notation of the music, however, need not be one which serves composer, performer and scholar alike. For purposes of analysis, at any rate, the notation should ideally reflect characteristics of the music which need not necessarily be included in the notation used by the performer. The Melograph recording provides in fact just such an example.[3]

[2] The systematic study of oral traditions is relatively new. An important attempt in historical methodology of oral traditions is Jan Vansina's *Oral Tradition* (tr. H. M. Wright), Chicago, 1965.

[3] Seeger believes that the Melograph, when used in conjunction with conventional notation,

2. *Applicability and Limitations of the Melograph*

The Melograph, as it will be remembered, renders a graphic picture of the lowest frequencies of a sound spectrum, provided that they are well defined. It is not suited for the recording of music composed of more than a single melodic line. Likewise, staccato singing will present recording problems since it introduces undefined frequencies.[4] Of course, accompanying noise above a certain volume will interfere with the recording picture. Thus the Melograph, unfortunately, cannot be employed successfully for most of the recordings done in the past by eminent scholars and collectors. Nevertheless, it remains an indispensable tool for an accurate analysis of music sung by solo singers and performed by some solo instruments. As for the reliability of the graphic record, it depends largely on the recording conditions.[5] All this limits us to certain kinds of music as well as a certain quality of recording.

Along with the inherent limitations of the Melograph, there exist also technical problems raised by the various possible ways of obtaining the graph. Although these are without doubt passing problems, we think some attention should be given to them here, because of their practical significance at the present time. A graph obtained by means of photographing the picture produced on the screen of an oscilloscope assures a fast and inertia-free response.[6] How-

presents the desired picture of all the elements characterizing a musical style, those elements which are perceived by the ear and those which are not; see Ch. Seeger, "Prescriptive and Descriptive Music Writing", in *MQ*, 44 (1958): 184–195. Merriam, however, realizes that the continuous Melograph "note" differs markedly from the isolated entity of the conventional note and raises the question whether such an entity can or should be isolated altogether; see A. P. Merriam, *The Anthropology of Music* (Evanston, Ill., 1964), pp. 59–60. While the need for concrete entities seems to be correct, it can be argued that conventional notation presents an artificial frame of reference, since it dictates a certain kind of intonation. Herzog claimed that the profusion of detailed visual data provided by the Melograph will raise new problems which will have to be re-translated into musical reality and musical sense. He was undoubtedly correct, but this should not have modified his enthusiasm, because the re-translation is not a literal one and may create a new musical reality and a new musical sense; see B. Nettl, *Theory and Method...*, p. 125.

[4] There are a number of technical devices which can be used to indicate the occurrence of undefined frequencies (breathing, of course, is an important example of this). We cannot go into detail concerning these methods here, but we would like to point out that all of these methods have their advantages and disadvantages. Different kinds of music dictate a different treatment regarding undefined frequencies. Since the choice depends on a great number of factors some of which are known and some of which are unknown, it is best to experiment meanwhile with all the possibilities and try to aim at the best results.

[5] The importance of the recording conditions was stressed by Dahlback through a series of experiments concerning the effect of change in velocity, voltage and its frequencies on the reliability of the resulting graph, see K. Dahlback, *New Methods...*, pp. 18–38.

[6] This is a system used by the Norwegian group. We also employed this system at the beginning of our study of the music of the Samaritans (see n. 11).

ever, a mechanical recorder, although less exact, is more convenient since the graph is produced instantaneously and can be watched and checked during the actual recording process. On the other hand, the mechanical stylus shows some inertia which causes "overshooting" of large intervals, or lagging whenever rapid changes in the direction of the melody take place. This problem can be solved by the use of an electric eye as the recording device. While such recorders are easily available on the market, they all respond linearly with the frequency, and not with the logarithm of the frequency. It seems to us that the logarithmic scale is of utmost importance for systematic work with large quantities of musical material, especially for questions pertaining to pitch. We are presently planning an electric eye recorder, especially adapted for our purposes, to which an exact logarithmic amplifier will be added.[7]

3. *The Appropriate Measuring Unit for Pitch Analysis*

Frequency is, of course, the main physical factor affecting the perception of pitch, and really lies at the root of all measurements of pitch. In practice, many different conventions have been used in estimating pitch and changes in pitch. A very convenient and well established scale is the logarithmic scale of the frequency. This has the great advantage of being additive: it is also the basis of the well-tempered scale of the piano. This additive scale has served European art music quite faithfully. However, experiments designed to discover a scale corresponding to the actual sensation of pitch have led to a new definition of unit of interval — the *mel*.[8] The *mel*-scale expresses the fact that equal intervals (as defined conservatively), when heard in different ranges of pitch, are not perceived as equal.[9] However, within the small range of frequencies of the human voice, the definition of pitch in terms of the logarithm of frequency is accurate enough, since it differs but very little from the *mel*-scale. Nevertheless, the absolute range of pitch in which the music lies must be taken into account.

For the treatment of intervals incorporating "microtones" of all kinds, frequency ratios have been used all through history. The so-called Cent System of Ellis was expected to solve two problems: Being an additive scale, it should facilitate the calculation of intervals and, likewise, permit the accurate measure-

[7] The most recent model of a Melograph we know of, the Uppsala specimen (see n. 1), does seem to use a very rapid recorder. From the pictures of the graph it is apparent that the response is not exactly linear with the logarithm of the frequency. However, the instrument provides for an accurate calibration of frequencies. It should be mentioned here that the Oslo "melody writer", as well as our first model, were not logarithmic at all.

[8] See W. A. Van Bergeijk, J. R. Pierce and E. E. David, *Waves and the Ear* (London, 1961), pp. 81–83, 162; see also P. Pedersen, "The Mel Scale", in *JMT*, 9 (1965): 295–301.

[9] The present discussion so far neglects other factors which may affect the perception of pitch, such as volume and timbre.

ment of eventual "microtones". The accuracy of measurement is assumed to be a hundredth of a semitone.

The curve of sensitivity to pitch discrimination, as a function of frequency and volume, shows that three cents represent the utmost limit for the sensibility of the ear,[10] and that only in the vicinity of 2000 Hertz and at an optimal volume and duration of the tone. However, around 250 Hertz which represents the normal singing range, even deviations of ten cents will hardly be perceived. Moreover, the studies of Metfessel, Seashore, Seeger, Gurwin, Cohen and Katz[11] have shown that the pitch of a vocal tone cannot be defined with an accuracy exceeding that of 1/10 semitone or 10 cents; this, by the way, is equally relevant for the playing of the violin. We see, therefore, that the cent is too small a unit to be significant in measuring differences of pitch in actual singing. This is true even in an upper range, not to speak of its significance in a lower range and at a rapid speed. As self-evident as this may seem, the cent-system still enjoys many devotees. It is remarkable that the less important factor, i.e. the difficulty of converting the frequency scale into the logarithmic scale of cents, should be viewed as the major problem of the system.[12]

Since the cent system has become entrenched, it may be easier to use this system because of its common denominator, provided that the basic unit should be ten cents (one Deca cent) rather than the single cent. Thus each semitone would consist of ten and the octave of 120 units. It is interesting to point out in this connection that the smallest pitch differentiations which are stressed both by Seashore as well as Seeger are no less than a tenth of a whole tone, namely twenty cents.[13] This results from the fact that both were dealing with the production and perception of tones empirically rather than hypothetically.

[10] See for example, A. Wood, *Acoustics* (London, 1946), pp. 469–470; C. E. Seashore, *Psychology of Music* (New York, 1938), p. 60.

[11] M. Metfessel, *Phonophotography in Folk Music*, Chapel Hill, N.C., 1928; C. E. Seashore, *Psychology of Music*, pp. 256–266; Ch. Seeger, "Prescriptive and Descriptive Music Writing", (see n. 3), Pl. III, p. 189; K. Dahlback, *New Methods...* (see n. 1), pp. 50–52, 82–84, 87, 89, 91, 93, 95–105; P. A. Tove *et. al.*, *Direct Recording...* (see n. 1), p. 370; D. Cohen and R. Torgownik-Katz, "Exploration in the Music of the Samaritans; An Illustration of the Utility of Graphic Notation", in *Ethnomusicology*, 4 (1960): 72–74; D. Cohen, "An Investigation into the Tonal Structure of the *Maqāmāt*", in *JIFMC*, 16 (1964): 105; R. Katz, "The Singing of Baqqašôt by Aleppo Jews; a Study in Musical Acculturation", to be published in *AMl*, 40 (1968).

[12] See E. Gerson-Kiwi, "Towards an Exact Transcription of Tone Relations", in *AMl*, 25 (1953): 81.

[13] C. E. Seashore, *Psychology of Music*, p. 204; Ch. Seeger, *Prescriptive and Descriptive Music Writing*, p. 193. It should be mentioned that already in Hornbostel's tonometer the octave was divided into 120 units; see the Hebrew edition of *HOM*, I, pp. 18–19.

4. *The Place of the Melograph in Ethnomusicological Research*

Bearing in mind the limitations of the Melograph as well as the basic problem concerning exact pitch-measurement, we should like to propose here a working method for the study of non-European monody. Listing the major factors of importance for the characterization of non-European music, one readily finds that most of them still lend themselves to an analysis by conventional methods, and only a few depend on the Melograph. The list comprises the following factors:

1. The ambitus of the melody
2. The absolute range in which the melody appears (the range may at times affect the perception of pitch)
3. Pivotal tones
4. Characteristic intervals
5. Characteristic motives
6. The melody and its formal structure
7. Presence of ornamentation and its types
8. Vibrato, considering its width, depth and place
9. Stylistic occurrences "between the notes": attack and decay of pitch, portamento, glissando, etc.
10. Tempi and their changes
11. Rhythm, characteristic patterns
12. Distribution of the text over the melody
13. Tonal skeleton
14. Manner of performance (solo singing, group singing accompanied, unaccompanied, etc.)
15. Consistency of the above elements on repeated performance; the degree and nature of their eventual variation.

Examining closely the above list, we see readily that only numbers 8, 9 and 13, and partly also numbers 11 and 15, depend on the use of the Melograph. Numbers 8 and 9 are obvious and have been examined by others using either the melograph or other graph-yielding devices.[14] Most of the other items have already been treated by scholars in various forms and to various extents.[15]

All the elements of the above list have been examined in our work as far

[14] See K. Dahlback, *op. cit.*, (n. 1), pp. 67, 86, 88, 94, 118, 120, 122, 159; C. E. Seashore, *op. cit.*, (n. 10), pp. 33–52; D. Cohen and R. Katz, "Exploration in the Music of the Samaritans" (n. 11), pp. 72–74.

[15] A description of the most important works can be found in B. Nettl, *Theory and Method in Ethnomusicology*, Chs. 5, 6, 8 and 9; Idem, *Music in Primitive Culture* (Cambridge, 1956), Chs. 3, 4 and 5; A. P. Merriam, *The Anthropology of Music* (Evanston, Ill., 1964), Ch. 3; Mantle Hood, "Music, the Unkown", in F. Ll. Harrison, M. Hood, Cl. Palisca, *Musicology*, 2nd. printing (Englewood Cliffs, N. J., 1965), pp. 217–326.

as possible. Complete analysis should include also research into timbre which is, of course, very important. We plan to do this in the near future.[16] In this paper we shall limit ourselves to number 13, the tonal skeleton, because it raises new questions and promises new insight.

Since the comparative method is the basis of all typological studies, we base our comparisons on the examination of the above elements in both different melodies sung by one informant and the same melody sung by different informants. Whenever a theoretical framework such as *maqām, mode, raga* is concomitant with a musical civilization, it may be used as starting point. Sociological and anthropological factors may also serve as organizing principles of comparison, e.g., the social or spiritual function of certain melodies or a given *maqām* in the overall tradition of a group.

5. *The Tonal Skeleton*

Studying the graphs of Arabic melodies obtained by the Melograph, we see that never does an informant repeat himself *verbatim.* This, to be sure, applies to a certain degree also to European music.[17] For example, upon measuring the pitches, let us say, of all the c's occurring in a melody, we shall observe that they scatter generally around a mean value. Hence establishing a skeleton of tonal degrees represented by a single frequency is misleading: it never occurs in the singing of human beings. Thus, for example, the method of comparing the singing of various Papuan singers employed by Kunst, is far from achieving the aims he himself had in mind.[18] He measured the exact frequencies of each tone in order to establish the tonal skeleton presented

[16] Spectrum analysis, while not new in linguistic studies, is relatively new in the study of comparative musicology. Spectrum analysis has also been treated in conjunction with the Melograph. However, no systematic study or method leading to a comprehensive rather than local picture of timbre has been made. Walter Graf in reporting on the utility of the sonogram (see W. Graf, "Moderne Klanganalyse und wissenschaftliche Anwendung", in *Schriften des Vereines zur Verbreitung naturwissenschaftlicher Kenntnisse in Wien,* 104 [Wien 1963/64]: 43–66) suggests that, in addition to the overtones, the basic frequency can be read in the resulting picture of the sonogram. While this is correct it should be pointed out that the degree of the accuracy of the basic frequency obtained in the pitch is very low. This is due to the fact that the sonogram combines frequency and volume as in visible speech. The intensity in this case blurs the exactitude of the pitch, and this is precisely one of the problems the Melograph was intended to solve, in order to indicate pitch with a degree of accuracy. Following the line of thought that has emerged from the work of the Melograph, we are presently engaged in finding means and ways to solve the important question of timbre.

[17] C. E. Seashore, *op. cit.* (n. 10), pp. 212, 259–266; Ch. Shackford, "Some Aspects of Perception", in *JMT,* 2 (1962): 67–90; P. C. Boomsliter and W. Creel, "Extended Reference: An Unrecognized Dynamic in Melody", in *JMT,* 7 (1963): 3–22.

[18] *A Study on Papuan Music,* Bandung, 1930.

by each singer and that with an (imagined!) accuracy of a single cent. Moreover, he attempts to establish the tonal skeleton on one single measurement of each degree. We have found from our experience with Palestino-Arabic song that it is precisely the shape and degree of the scatter of the single tone which characterizes the singing of different individuals or different groups; it may also be typical of a given song, mode or *maqām*. Moreover, musically speaking, the pitch of the single tones is of lesser interest than the intervals created by them. It is possible to imagine, for example, the rise in pitch of the whole melody, while the interval relations are kept fixed. Therefore, concentration on the measurement of single tones only distorts the picture of the real skeleton, though establishing the fact that the melody has risen in pitch may well be of interest.

To establish the tonal skeleton of a melody, we first of all examine the sizes of all the Seconds (adjacent notes) and their changes in the course of the melody. As a result, we get various Seconds with their scatter. The various sizes of this interval are arranged according to a scale in which each unit represents 1/10 semitone. All the occurrences of a specific Second are entered on a graph (Fig. 3).[19] For the completion of the picture, we also measure the scatter of intervals other than the Second since the average of two intervals does not necessarily equal the average of their sum. It is easy to compare such diagrams and to locate unanticipated relationships between different melodies, different informants, different renditions of a so-to-speak "tonal organization" and, of course, of different musical traditions.

As for the names of the tonal degrees, it has been customary among ethnomusicologists to prefer the movable-*Do*-system because it facilitates easy comparisons. However, using this system is artificial whenever a modal or scalar framework already exists in the culture in question. It would be absurd, for instance, to use any note other than *Re* for the lowest note of the scale of songs cast in *maqām Bayāt*, or to use any note other than *Mi* for melodies cast in *maqām Sīga*.

As an illustration of the method employed in establishing the tonal structure, we here present the tune *Indama*, a song most popular among Christian Arabs in Israel. It is a tune in *maqām Sīga*. *Mi* and *Sol* serve as tonal centres; the motifs of the tune which are typical of songs in *maqām Sīga* pivot around these tonal centres. Our examples represent the singing of two different informants.

We can readily observe in the curve diagram of the melody (Fig. 1) that the Seconds are anything but tempered (a whole tempered tone is represented by six lines on the scale of the recording paper). We can observe as well that the size of the interval of the Second is not a stable one and changes not only in

[19] We are planning to adapt a computer as a frequency reader, to replace the tedious work of the measuring of the intervals by counting the lines on the scale.

variations of the same motif, but even in the "literal" repetition of the motif. From the occurrences of the different sizes of each of the Seconds which appear on several repetitions of the same song, we obtain the average sizes of these Seconds and their scatter. What we in fact get here is the tonal skeleton of the tune. For, unlike Western music, Seconds are omnipresent in Near Eastern music, and the relationship between all the intervals of the Seconds is most important in this music. In Western music, intervals other than the Second such as the Octave, the Fifth and the Fourth, can dictate an inner subdivision in such a way that a change of the size of one Second will be compensated by the size of the adjacent Second, so that their total sum will remain constant. An examination of a large body of Near Eastern vocal music reveals that the Fourth and Fifth are anything but stable and that, on the other hand, the interval of the Second and the special relationships among Seconds does reveal a certain regularity and plays an important part in the characterization of different types of that music. In order to complete the picture of the tonal structure one should, of course, examine the average pitches of the single tones and their scatter as well as the sizes of all the other intervals which occur in the melody.

For purposes of illustration we have limited ourselves to a few examples only. To illustrate the scatter of different tones we have chosen a popular Israeli song (Fig. 2) sung by an Israeli music teacher of European descent. For reliability of the results, the song was repeated four times. The song itself can be considered Western in so far as the tonal skeleton is concerned. Without elaborating in great detail, it will suffice to mention that this example can also serve to illustrate what can be perceived on Western standards as "correct" and sung "on pitch".[20]

[20] Interpretations of deviations from tempered tuning in the actual performance of music centre around factors such as accidental causes, use of Pythagorean or natural scales, special music environment dictating deviations etc. While some of these explanations are undoubtedly correct, it seems to us that the overriding factor is a "hidden" desire to escape being "on pitch" in order to avoid "mechanical sterility". Indeed, various experiments have shown that people prefer melodies the tones of which have scattered rather than fixed frequencies. The notion that one should be able to assess, so to speak, "the aim" of the performer despite deviations, is basically wrong, since it assumes off-hand that the performer has such an absolute aim in mind. The opposite is true, if one can at all talk about aims or intentions. The intention here is in the direction of a scatter of frequencies. The experiments referred to by Boomsliter and Creel (see n. 17) show that no composer, when left with a choice, selects either just intonation, or Pythagorean or equal temperament scales throughout. They all reject intonations with fixed frequencies in favour of a system incorporating a scatter of frequencies, with different degrees of scatter for different tones. However, the explanation put forward by Boomsliter and Creel for this phenomenon is hardly convincing. Though their idea of extended reference is somewhat similar to our tonal skeleton, the frequencies which represent the scatter in their case are artificially derived from an arbitrary system

For the illustration of the sizes of adjacent Seconds (from which we get the tonal skeleton) we chose, on the one hand, the popular Arabic song *Indama* as sung by two different informants (for sections of this graph see Fig. 1), and, on the other hand, the popular Israeli song *Qôl Dôdî* as sung by two music teachers.

Close comparison of Figs. 3a and 3b show that they correspond to two different skeletons of the song *Indama.* Indeed from the many examples we have of the same song, we were led to conclude that these two skeletons are representative types, each one corresponding to a particular group of informants. These groups can be classified according to other criteria such as geographic area, social class etc. Turning to the Israeli song *Qôl Dôdî* (Fig. 4) we see that here too, as expected, we find instability of the Second but the average of each Second moves around the tempered value.

6. *Conclusion*

We have seen that the tonal skeleton taken even by itself carries weight in the characterization of a musical style. Unfortunately we are unable to elaborate here upon the musical significance of the tonal skeleton and the interesting conclusions one can derive from it. We do hope, nonetheless, that we have succeeded in pointing to vistas of investigation which have hitherto been overlooked. Although we are fully aware of the importance of all the items included in our list of characterizing elements, we have intentionally concentrated on the tonal skeleton since, as already explained, it is less obvious than the other elements. It was anticipated that the Melograph would give a picture of the stylistic elements which take place "between the notes", such as attack and decay of tones (from the point of view of pitch), vibrati, glissandos, etc., while the picture of the tonal skeleton is an unanticipated result of the analysis obtained with the aid of the Melograph. It should be emphasized that even the measurement of all the intervals occurring in the performance of a particular song can be misleading, if the concept of interval is that of a fixed size. As we pointed out, intervals fluctuate; the form and degree of their fluidity may be characteristic of a certain song or *maqām.* A single measurement of intervals cannot give an accurate picture of either a single song sung by different informants, or of many songs sung by the same informant — not to speak of a picture of the musical heritage of an entire group.

which contains an arbitrary hierarchy. The tonal skeleton in our case is obtained without the assumption of a super-imposed pre-existing speculative system, and although less neat, is exacted from reality itself.

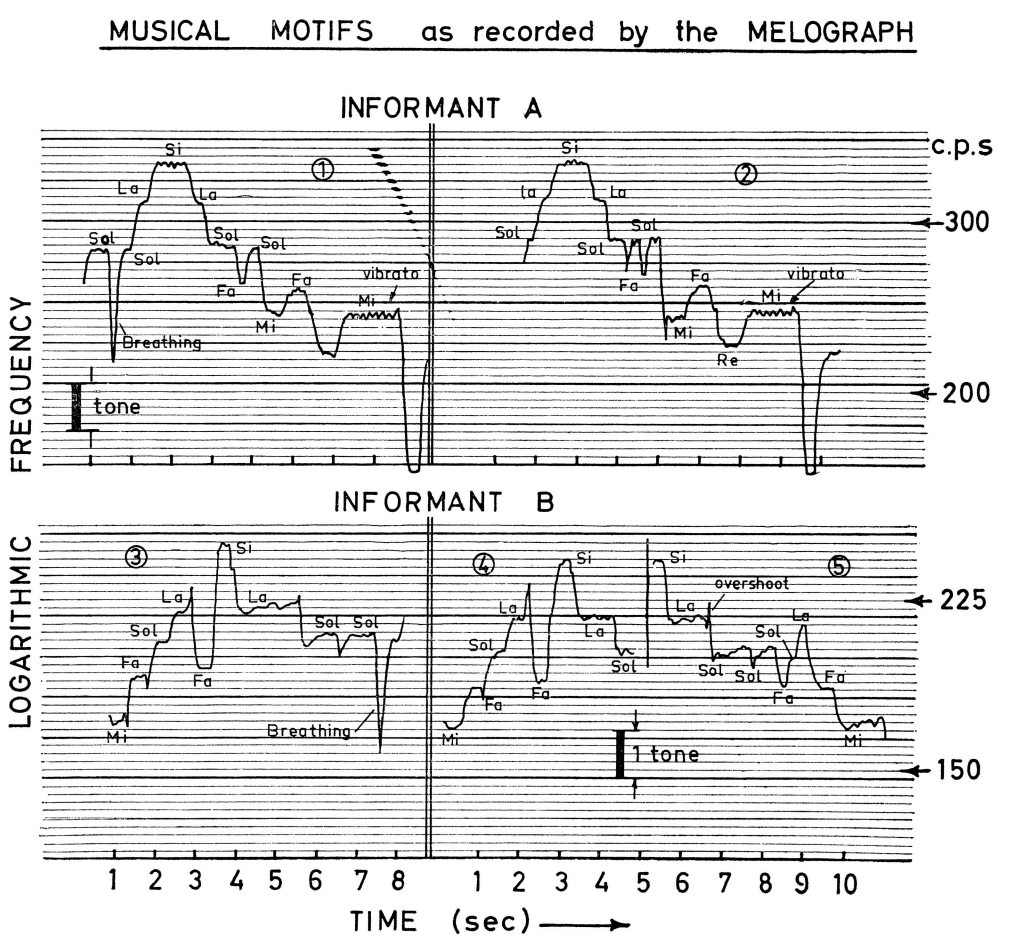

Fig. 1. Recurrent musical motifs from the same song *Indama* sung by two Israeli Arabs.

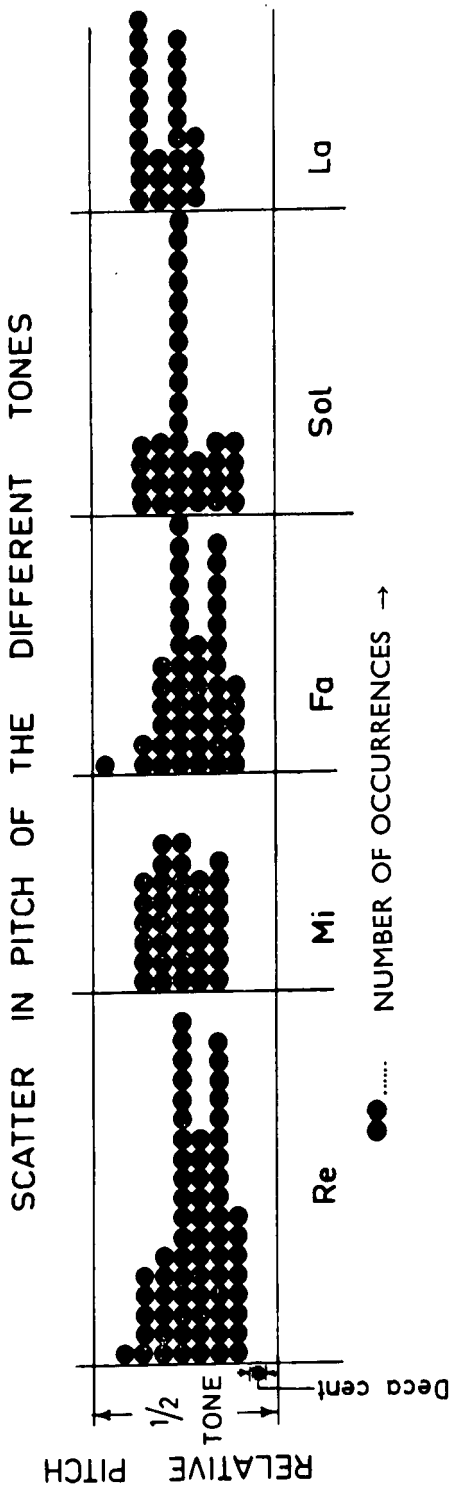

Fig. 2. Distribution of frequencies of the different tones in the Israeli folk song *Qôl dôdi* (repeated four times), illustrating the degree of tonal stability. The vertical axis indicates relative pitch for each of the tonal degrees. The 5 squares represent the 5 tones occurring in *Qôl dôdi*. Every black dot stands for one occurrence of the tone indicated by the square. The dots have been arranged in different lines which, by reference to the vertical axis, indicate the different pitches intonated by the informant at several repetitions of the tone. Example: the 34 black dots in the square of the note *sol* represent a total of 34 occurrences of that tone. The 15 occurrences found in line 3 from above were identical in pitch and, therefore, arranged in the same line (by the same "pitch" we mean of course pitches in the range of one Deca cent).

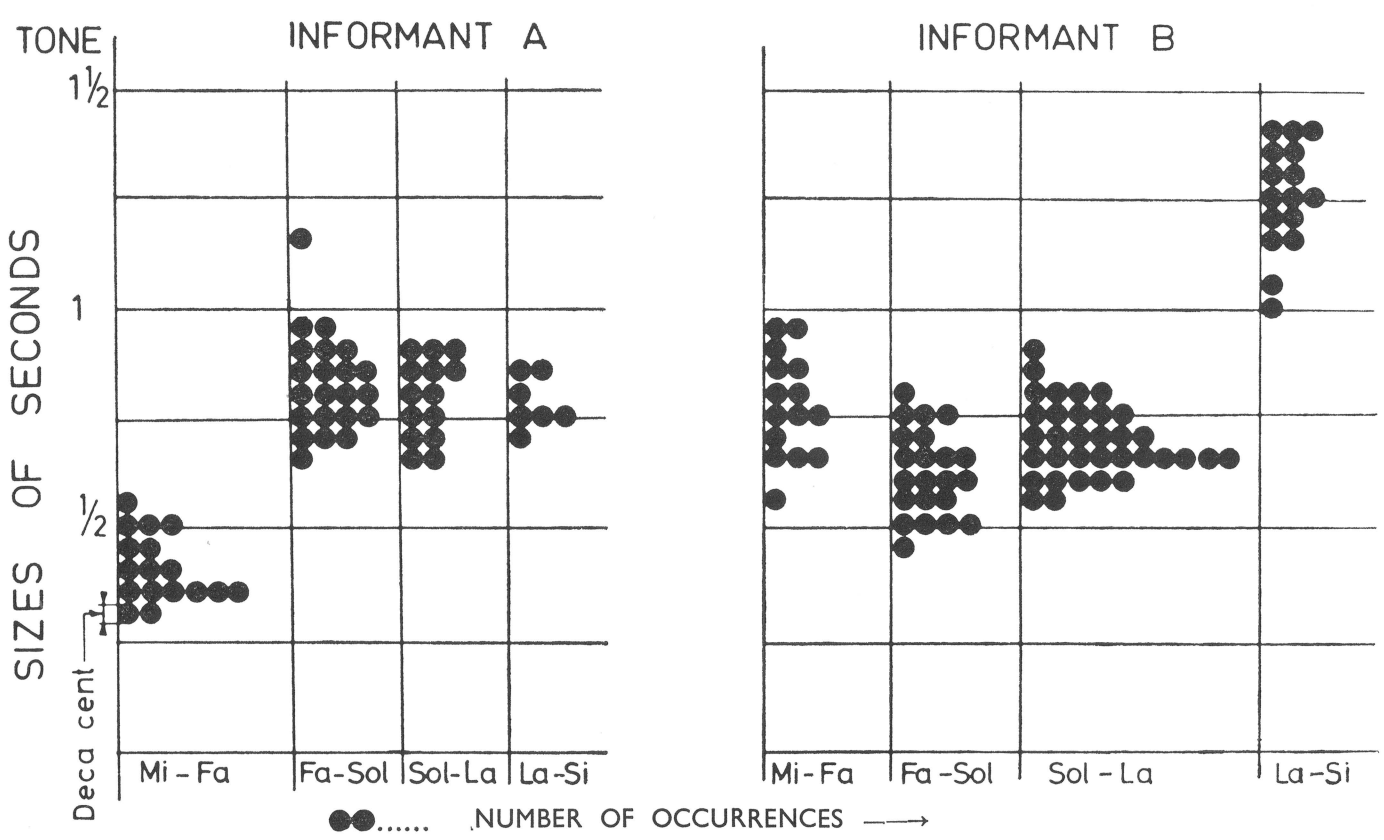

Fig. 3. Distributions of the size of the intervals between adjacent tones (Seconds) in the song *Indama*, giving two different tonal skeletons of this song. The 4 columns assigned to both informant *A* and *B* represent the intervals of the adjacent Seconds in this song. The black dots found in a column indicate, by their relative position, the different sizes of a certain Second and the number of their occurrences in the song. Marked differences between the intonation of informant *A* and *B* are noticed. Example: The 1st column of informant *A* contains 17 dots = 17 occurrences of the interval *mi-fa*. Three out of these 17 dots have been placed just upon the line marked "1/2", that means that they were in accordance with the tempered half-tone.

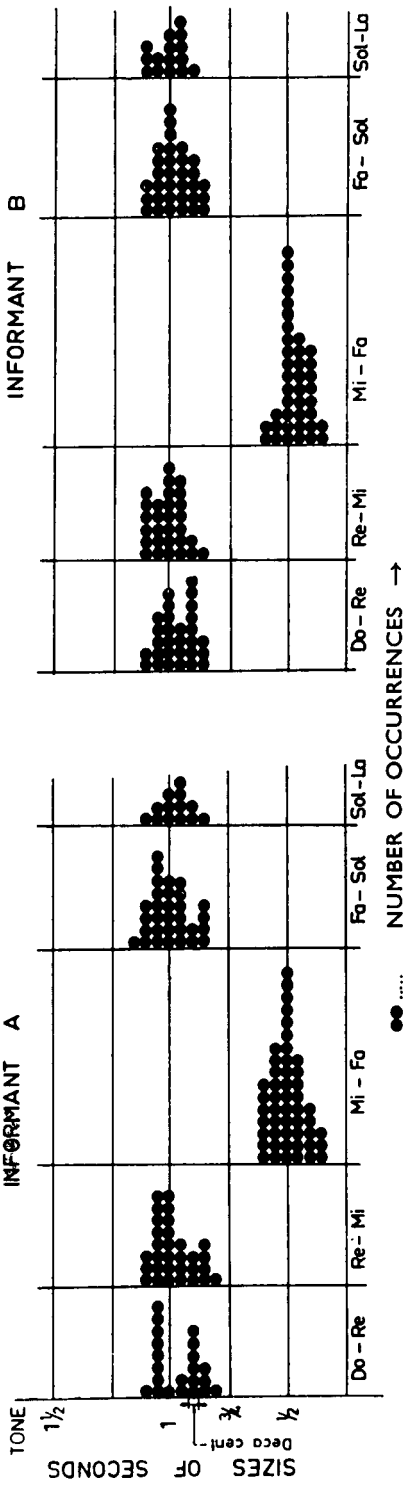

Fig. 4. Distributions of the size of the intervals between adjacent notes (Seconds) in the song *Qôl dôdî* (Fig. 2) sung by two Israeli music teachers.

YUVAL

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ABBREVIATIONS

(N.B.: The special abbreviations and sigla used by N. Allony are listed at the end of his article.)

AHw	W. von Soden, *Akkadisches Handwörterbuch*, Wiesbaden, 1959 →
AL	M. Steinschneider, *Die arabische Literatur der Juden*, Frankfurt a.M., 1902
AMl	*Acta Musicologica*
b	Babylonian Talmud
CAD	*The Assyrian Dictionary of the Oriental Institute of the University of Chicago*, Chicago, 1956 →
CB	M. Steinschneider, *Catalogus librorum Hebraeorum in bibliotheca Bodleiana*, Berlin, 1852–1860
CS	E. de Coussemaker, ed., *Scriptores de musica medii aevi...*, Paris, 1864–1876
DTO	*Denkmäler der Tonkunst in Österreich*
Eissfeldt	O. Eissfeldt, *The Old Testament — An Introduction* (tr. from the 3rd German edition by P. R. Ackroyd), Oxford, 1965
Enc. Mus. Fasquelle	*Encyclopédie de la musique*, Paris, Fasquelle, 1958–1961
Erlanger	R. d'Erlanger, *La musique arabe*, Paris, 1930–1949
Farmer, *Gen. Fragm.*	H. G. Farmer, *The Oriental Musical Influence and Jewish Genizah Fragments on Music*, London, 1964; repr. of two art. from *Glasgow University Oriental Society, Transactions*, 19 (1963): 1–15 ("The Oriental Musical Influence" = pp. 7–21 of repr.); 52–62 ("Jewish Genizah Fragments on Music" = pp. 22–32 of repr.)
GS	M. Gerbert, ed., *Scriptores ecclesiastici de musica...*, Sankt Blasien, 1784
HOM	A. Z. Idelsohn, *Hebräisch-orientalischer Melodienschatz*, Leipzig–Berlin–Jerusalem, 1914–1932
HU	M. Steinschneider, *Die hebräischen Übersetzungen des Mittelalters*, Berlin, 1893
HUCA	*Hebrew Union College Annual*
IMS	International Musicological Society
IQ	*Islamic Quarterly*
JA	*Journal Asiatique*
JAMS	*Journal of the American Musicological Society*
JIFMC	*Journal of the International Folk Music Council*
JMT	*Journal of Musical Theory*
JQR	*Jewish Quarterly Review*
KS	*Kirjath Sepher*
m	Mishnah

MD	*Musica Disciplina*
MGG	*Die Musik in Geschichte und Gegenwart*, Kassel, 1949 →
MGWJ	*Monatsschrift für Geschichte und Wissenschaft des Judentums*
MQ	*Musical Quarterly*
NOHM	*New Oxford History of Music*, London, 1955 →
PAAJR	*Proceedings of the American Academy for Jewish Research*
PL	*Patrologia Latina* (ed. Migne)
1Q	Dead Sea Scrolls, Qumran Cave 1
1QH	"Thanksgiving Scroll"
1QM	"War Scroll"
1QS	"Manual of Discipline"
REI	*Revue des Etudes Islamiques*
REJ	*Revue des Etudes Juives*
Riemann, *Hbd. Mg.*	H. Riemann, *Handbuch der Musikgeschichte*, Leipzig, 1919–1922
Riemann, *ML*	H. Riemann, *Musik-Lexikon* (quoted edition indicated by exponent)
RM	*Revue de Musicologie*
RQ	*Revue de Qumran*
SIMG	*Sammelbände der Internationalen Musikgesellschaft*
Steinschneider, *Cat. Berlin*	M. Steinschneider, *Verzeichnis der hebräischen Handschriften [der Königlichen Bibliothek zu Berlin]*, Berlin, 1878–1897
VT	*Vetus Testamentum*
y	Jerusalem Talmud
ZAW	*Zeitschrift für die alttestamentliche Wissenschaft*
ZDMG	*Zeitschrift der Deutschen Morgenländischen Gesellschaft*
ZfMW	*Zeitschrift für Musikwissenschaft*
ZGJD	*Zeitschrift für die Geschichte der Juden in Deutschland*