“Singing like the Gaida (Bagpipe)”: Investigating Relations between Singing and Instrumental Playing Techniques in Greek Thrace

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Background in ethnomusicology. In the region of Thrace, as well as in the wider Balkan area, a special singing style has been observed, which is closely related to ‘open throat’ singing techniques. This practice is often associated with low pitch sounds, produced by glottal stops, and some high pitched ‘screaming’ tones (Rice 1977). Furthermore, the aforementioned singing techniques are strongly connected with the playing techniques of the gaida (bagpipe) (Levy 1985, Rice 1994, Sarris 2007), an instrument that is found with minor variations from Romania to continental Greece.

Background in acoustical analysis. Acoustical analysis has played an important role both in spoken and singing voice research during the last decades. From linguistics and phonology, to speech synthesis, many applications utilize the analysis of the voice and the data that derive from it. Pitch extraction, intensity contours, formants, and spectrograms are a few of the elements used in the acoustical analysis of the voice. Although many studies focus on the analysis of Western opera or pop music singing techniques (Bloothooft & Plomp 1986, Sundberg 2001, Thalén & Sundberg 2001), little research has been performed on the acoustical analysis of traditional or nonwestern singing (Ross 1992, Delviniotis 1998).

Aims. In this study, we examine the potential link between traditional singing and the music of the gaida in Greek Thrace with respect to techniques and aesthetics, using ethnomusicological resources and acoustical analysis.

Main contribution. Are singing and gaida playing two sides of a single coin? Ethnomusicological research can support this statement. However, until now, there have been no measurements or analytical data to support the connection between singing and gaida playing techniques. Can acoustical analysis shed some light on the aforementioned argument? We proceeded with an acoustical analysis of both songs and gaida pieces that were recorded during the Research Programme “Thrace” project. Singing technique as observed in these recordings was found to present great similarities with gaida technique.

Implications. Singing in Thrace is a complex and multidimensional phenomenon. Results and observations found in this work could be very useful to singers and researchers, performing and studying this particular singing style in Thrace, in the Balkans or wherever a similar style occurs. Ethnomusicological research and voice analysis could benefit from both approaches presented in this paper: ethnomusicologists should validate aesthetic arguments using analytical methods like acoustical analysis, while analytical results should be interpreted under the light of the ethnographic context. Thanks to modern technology, one can look at the very basic elements of sound, realizing unexpected correlations between topics such as singing and instrument playing.

Keywords: Gaida, bagpipe, folk singing, acoustical analysis, glottal stop, Thrace, Balkans

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Introduction

What is there in common between the human singing voice and a musical instrument? Can an instrument be the material projection of a society’s music? Can we draw parallels between singing and instrumental music through the perspective of social context?

Questions like the aforementioned rise if one compares specific vocal techniques used in various singing traditions of the Balkans with the technical possibilities of the *gaida*, a bagpipe widely spread in the same area. These vocal techniques appear in many geographical areas and music traditions, and have been described in the ethnomusicological bibliography. Along with stylistic differentiations from place to place, there are commonalities such as the nature of the vocal production, which is characterized by a projective, open-throated resonance enhanced by a variety of distinctive embellishment techniques, e.g. vocal trills, shakes, and glottal ornamentation. This style is heard in choirs marketed as ‘mysterious’ Bulgarian voices, with which the international audience is most familiar (Buchanan 1997: 139). Krader (1987: 12-13) refers to similar techniques used in the *ganga* polyphonic song of Hercegovina. Rice (1977: 78), in his doctoral thesis on Bulgarian polyphony, links these vocal techniques with *gaida* playing technique. He notes (1977: 81), however, that the use of these techniques varies from singer to singer, that they are not necessarily considered to be evidence of good singing, and that they are not related to the singer’s age.

In Greece, such practices are found in Thrace, in polyphonic songs of native populations of Macedonia, in polyphonic songs of Epirus, and in various traditions of continental Greece. Even though there is no ‘map’ indicating the diffusion of these techniques, we believe that it is a common practice throughout many rural societies of the Balkans. Perhaps it is not irrelevant that the *gaida* is (or was in the past) also widespread throughout the same region (Baines 1995: 82-86, Sarris 2007: 92-95).

In this paper, we examine whether there is a ‘common ground’ between the singing voice in Thrace and the *gaida*’s music, in terms of melodic ornamentation and aesthetics. First of all, the technical potentials of the *gaida* are described, while referring to the social context in which the *gaida* and singing interact. It is from this point of view, then, that we study the specific technical characteristics of singing.

Following other studies on the acoustical analysis of traditional or nonwestern singing (Ross 1992, Delviniotis 1998), we proceed with the analysis of selected songs from the Research Programme “Thrace” music corpus, as well as from other recordings that were conducted especially for this study, data including waveforms, pitch and intensity contours, spectrograms, and spectrum envelopes are presented for both singing and *gaida* tracks. Similarities in singing and *gaida* performing techniques are illustrated and described. Finally, based on these similarities, we point out factors that a singer or researcher should have in mind while approaching this particular vocal style.
The gaida

The gaida (bagpipe) (Fig. 1, middle) consists of two cylindrical pipes with single reeds. The short one is the chanter (Fig. 1, left), and the long one is the drone (Fig. 1, right), which sounds the tonic two octaves lower than the chanter. In all gaidas, the tonic lies in the middle of their range, contrary to some aerophones, like the zournas (shawm) or the clarinet, where the tonic often lies in the lower notes (Tzevelekos & Kouroupetroglou 2004).

Figure 1. Left: Gaida chanter. Middle: Vangelis Kekes (gaida), from the village of Kyani, Evros. Right: Gaida drone.

The gaida has an ambitus of an octave (noted from E₄–E₅ in Fig. 2, with the A₄ as the tonic), divided into two registers: the high register above the tonic, which is the more sonorous, and the low register below the tonic, which is less sonorous. Most songs and tunes use a range of a sixth, (G₄–E₅), while the low register is mainly used for fast passages. However, the low register is used to a greater extent in slow, table songs: a primarily vocal repertoire, which in many cases does not seem to take into account the gaida’s peculiarities (Sarris 2007: 362-64). In such cases, one should investigate the influence of instruments such as the floyera (flute) or the clarinet (ibid.).

Like all bagpipes, the gaida produces a continuous sound due to the constant flow of air through the reeds. The musician cannot articulate the melody by tonguing, because he does not have physical contact with the reeds, nor can he play pauses or rests,
staccato, or even the same note twice in succession. Furthermore, bagpipes do not have a range of dynamics. Generally speaking, the higher the note, the greater the volume, so the loudest note is E5, while the least sonorous is E4.

![Figure 2. Range and fingering chart of the gaida.](image)

_Gaida_ players have developed special techniques to overcome what might be considered the limitations of the instrument. First of all, they use the ‘flea-hole’, a distinctive organological element of many Eastern European bagpipes, which consists of a small tube, usually made of a hen’s feather, slotted into hole I (Fig. 3). The flea-hole is an important component of the _gaida_’s playing technique, since it affects the way holes I and e (the thumb-hole, which is opposite to I) act. For a given fingering, by uncovering the flea-hole, an interval of a second above the note originally sounded is produced. The size of that interval depends on the original note. The higher the note, the smaller is the second.

_Gaida_ players use the flea-hole in three ways: a) melodically, through cross fingering\(^2\), b) to produce several kinds of melodic ornaments, i.e. trills and mordents (Audio sample 1, follow [www.musicstudies.org](http://www.musicstudies.org) for all audio samples), and c) in the ‘pitch vibrato’ effect, which is produced by partly uncovering the flea-hole periodically (Audio sample 2). Apart from the pitch vibrato, there is also the pulse vibrato, which is used in the higher notes of the high register, and is produced by the periodic covering and uncovering of the lower holes, mainly those played with the lower hand. Hence, a slight differentiation in sound is produced, due to the interchange between the ‘open’ and the ‘partly-covered’ fingering techniques (Audio sample 3).

Melodic ornaments and vibrato characterize the sound aesthetics of the _gaida_. They ‘break the monotony’ of the instrument’s continuous sound and they produce an interesting and expressive melody line. The use of vibrato is dominant in slow table
songs, where many long sustained notes are played (Audio sample 4). In rhythmic dance songs, some gaida players use ornaments wherever they can, sometimes in every note longer than the metric unit (Sarris 2007: 359-62).

Figure 3. X-ray photos of gaida chanter. Hole I is circled.

Recent research indicates that the vibrato effect characterizes repertoire that is idiomatic for the gaida, whereas it is not widely used in repertoire influenced by the zournas (shawm) or the clarinet. In the latter, which is highly influenced by the makam system, extended mordents are preferred instead of vibrato. We believe that this tendency is associated with the ‘playability’ of such ornamental schemes on the zournas or the clarinet. (Sarris 2007: 362-64).

Another technical characteristic of the gaida is achieved by uncovering the thumb-hole, the highest and most sonorous note of the instrument. This note is used not only melodically, but rhythmically as well. Thus, within the melody developed in the lower notes, the rapid, high notes create a rhythm – a kind of internal percussion that accompanies the melody (Audio sample 5). This technique has been mainly developed in areas where the gaida is not accompanied by percussion, as in Greek Thrace. In areas where the gaida is accompanied by rhythmic instruments, such as the dauli (drum) or the dahare (frame drum), as in Greek Macedonia, this technique has not been developed.

On the other hand, E4 is the least sonorous note of the instrument. Sounding together with the 3rd harmonic of the drone, it is overshadowed by the omnipresence of the latter. When sounding between two higher notes, it helps the piper introduce articulation. It can give the sense of staccato, or a break between notes, since it is the closest approximation to silence that a gaida can provide (Audio sample 6).
The techniques described above enable the piper to overcome the limited possibilities for articulation on the *gaida*. A summary of the main technical characteristics of the *gaida* includes its narrow range divided in two registers, its continuous sound, and special articulation techniques used to overcome the absence of tonguing: the technique for separating notes by dropping down to the lowest (most quiet) note, the technique for marking the rhythm with the highest note, and the multi-functional use of the flea-hole. The use of these practices has a great impact on the distinctive melodic aesthetics of the *gaida*’s music.

The social context

Before examining the similarities between instrumental and vocal techniques, it is necessary to outline the social context of both *gaida* playing and singing. The *gaida* is an instrument associated with the old agricultural societies of Thrace, which were characterized by introversion, endogamy, and autarchy in economic, social and cultural behaviors (Avdikos 2002: 48). Until 1922, what is now Greek Thrace (see Fig. 4) was part of the Ottoman Empire, populated by a mosaic of national groups: Greek Christians co-existed with Turks, Pomaks, Bulgarians and Roma, as well as various other ethnic groups (Chtouris 1999). The *gaida* was a more or less common instrument for all: it was mainly related to societies which had the abovementioned characteristics, regardless of religious or linguistic identity. Being an inseparable part of festivals and rituals, it was part of the musical life of those societies (Sarris 2007: 98-104).

![Figure 4. Map of Thrace (dark gray-marked region).](image)

Things changed dramatically after 1923, with the compulsory exchange of populations between Greece and Turkey (Treaty of Lausanne, July 24, 1923) and between Greece and Bulgaria (Treaty of Neigy, November 27, 1919), with the aim of creating nation states with homogenous populations. After WWII, many Moslems
from Greek Thrace (who were exempted from the exchange, along with the Greeks of Istanbul) moved to the cities of Thrace, in keeping with the general urbanization of that era. That is the time that we ‘loose the tracks’ of the *gaida* among Moslems, while the instrument survived in the hands of Greek Christians exclusively.

What we observed in the late 1990s was the survival of the *gaida* mainly in the Evros region, where we have a dense Greek-Christian population. The Greek Civil War and emigration caused the devastation of the agricultural societies which were the social environment of the *gaida*. At the same time, the clarinet was elevated as the bearer of music modernity in post-War Greek Thrace (Sarris 2007: 115-22). Hence, contrary to data indicating that the *gaida* was omnipresent some decades ago, only 30 *gaida* players were found in the 1990s, most of them being well over 70 years old, while 20 of them were from Evros.

Unfortunately, we learned very little about the use of the *gaida* among Moslem populations (especially in the areas of the Rhodopes and Xanthi) through our fieldwork data, and the bibliography does not provide much relevant information. It seems that this tradition among Moslems declined as a result of events related to population exchanges, WWII, and the post-war urbanization. A few Roma, mainly from the Rhodopes, have become involved with the *gaida* recently. In the view of local non-Romani musicians, Roma do not seem to have a strong relationship with the instrument’s tradition. They have learned to play a rather limited number of well-known songs and tunes, in order to play in the street-markets or in the villages, begging for money. Hence, they have taken advantage of the nostalgia the sound of the instrument creates for the older generations. Non-Romani *gaida* players are rather critical of them, and they do not consider them as true *gaidatzides* (*gaida* players), but rather as beggars (Sarris 2007: 132-35).

Anyone who wishes to understand the old agricultural societies of Thrace, which were the cultural environment of the *gaida*, must comprehend how Thrace was before the historic landmarks of the first half of the 20th century. He has to evaluate data mined from local residents who have memories of the pre-1950 era, and must conceptualize the role of the instrument at that time.

The *gaida* was one of the most important instruments in the agricultural societies of Thrace. It was a part of the men’s world: young male shepherds spent their time in the fields playing the *gaida*, while the girls learned the song repertoire at home, in conjunction with house chores during their upbringing. This ‘gender separation’ of music continued in adolescent life. The *gaida* was played almost exclusively by men, while women were the main carriers of the song repertoire. Rice (1994: 127-52) enlarges upon the *gaida*’s performance in the context of the rural societies of pre-socialist Bulgaria, indicating the inter-connections between the life cycle of courtship and the calendrical cycle of work and ritual. Apart from the unquestionable variations from place to place, the basic elements of Rice’s description are also valid in most agricultural societies in the Balkans, including Greek Thrace.
Calendrical festivals in these societies are the place where the two musical worlds of men and women join together. Most formal festivals (such as Christmas, Carnival rituals, and Easter dances), where almost all members of the society participate, take place in open spaces, such as village squares or crossroads, in order for everyone to have room to dance or just observe the event. The sonorous sound of the *gaida* is the most suitable for such an occasion. The *gaida* is not required in order to ‘spin a dance’, though. Many dances take place accompanied only by the singing of women, who sing antiphonally. The first group (usually two singers) from the right (leading) part of the dance line starts the first phrase of the song, the second group from the left (following) part of the line repeats, and then the first group sings the second phrase, the second repeats, etc. Generally speaking, the right part of the line was the place for elderly women, while the younger ones were on the left. This way, younger women could learn the song repertoire simply by repeating (Rice 1994: 56). It is worth mentioning that, in Greek Thrace, during the three-day festivities for Easter, the *gaida* had a rather peripheral role, since dancing with unaccompanied women’s songs was preferred in that context. The symbolic language of the songs was used as a tool for the symbolical ‘re-baptising’ of the members of the community to their community’s morals (Terzopoulou 1999).

It is obvious that, if a ‘chorus’ consisted of only a few members, they certainly had to sing loudly, in order to be heard throughout the clamorous square. Hence, they had to develop some special techniques in order to meet that challenge.

### Comparing instrumental and vocal transcriptions

In order to examine the abovementioned playing techniques of the *gaida* and link them with analogous aspects of singing, we relied upon the experience of one of the two co-authors of this paper gained through the *Research Programme “Thrace”*. He investigated these techniques through fieldwork in the northern Greek provinces of Thrace and Eastern Macedonia in the late 1990s, as well as through undertaking the transcription of the program’s sound archive of about 3000 items. This research indicated that we are dealing with techniques that are shared by a variety of music traditions in southeastern Europe. This study may therefore act as a bridge to the investigation of these music practices wherever they are used.

The following transcription (Fig. 5, left, Audio sample 7) gives us an idea of the use of the abovementioned *gaida* techniques in the context of a tune. It is a segment of a *Zonaradikos* dance from the village of Patagi in Evros (code: Md109_2 of the “Thrace” archive). These techniques are observed throughout the instrument’s entire repertoire. The transcription is very rich in ornaments, appearing as high and low articulation notes. Specific ornament combinations embedded in the melody (*Γ* section) reinforce the metric pattern. The melodic line moves mainly within the high register of the *gaida*, with some use of G4. E4, the lowest note, is used only in ornaments, in conjunction with high pitched notes.
Regarding vocal techniques, the ‘open-throated’ vocal production enables a singer to be heard in a clamorous village square: it is a trumpet-like projection of the voice from the throat, with little benefit of head, nasal or chest resonance. According to Rice (1977: 78), “one of the interesting side effects of this projected, loud tone is the release of air and sound as the tone is stopped. Instead of the tone simply coming suddenly to a stop or fading out, a low-pitched grunt, caused by a glottal stop, is the typical way to end a held note at the end of a phrase”.

Rice also notes that “the glottal stop, in general, is an important device for separating one tone from another and is used alternately with more legato transitions from note to note. Some singers manage to emit a high-pitched tone an octave or so higher than the tonic which serves the same function - separating two melody notes” (ibid.). At this point, we may consider this way of singing as the ‘vocal equivalent’ of the continuous sound of the gaida.

By examining songs from the Research Programme “Thrace” archive, we have noticed that the low-pitched grunt mentioned by Rice takes place frequently at the beginning of phrases, in both men and women singers. On the other hand, the characteristic high-pitched tone is mainly used by women. As we will see below, this tone may or may not be produced by a glottal stop. It is used to separate notes, as well as to emphasize them. According to our research, this technique is not necessarily limited to ‘open throated’ singing. Low-pitch grunts are used widely, especially at the beginning of phrases, while high-pitch tones occur less frequently.

The following transcription (Fig. 5, right, Audio sample 8) offers us an idea of the use of these techniques in the context of a song. It is a wedding song from the village of Petrota, in the northern Evros area of Greek Thrace (code: Md016_20 of the “Thrace” archive). A comparison with the gaida transcription (Fig. 5, left) illustrates similarities between instrumental and vocal techniques. The vocal performance is also rich in ornaments. The low-pitch grunt at the beginning is evident and high-pitch escape notes are frequently used, both at the beginning and the ending of phrases as well as between repeated notes. The melodic line in the vocal piece is also confined above A4, with the exception of subtonic G4.

Some aspects of vocal performance practice may not be apparent from the transcription. One of them is the women’s practice of singing with an unusual high-pitch, shrill voice that is widely used in the villages of the Evros region. We observed that the tonic of women’s singing was usually related to the tonic of the gaidas of their area, which was between A4 and C5. We can assume that the women adapted their range to match the gaida, which generally fits better with a male voice. This practice, and others such as the use of vibrato, is examined in a following section, with the help of sound analysis.
Singing in a modern world

One important phenomenon observed during our research is that the abovementioned techniques were used mainly by elderly people, especially women, who grew up before WWII. This phenomenon is due to changing social structures during the post-war era. In the old context, while dancing in the village squares, participants had to sing loudly to be heard. The *gaida*, being a widely used instrument in those agricultural societies, could have possibly influenced singing technique.

The situation changed dramatically after WWII. Rapid urbanization, emigration, and the diffusion of radio and television resulted in the decay of the old social structures. Clarinet-led bands became widespread, while the *gaida* declined, since it was an expression of an ‘old fashioned’ world (Sarris 2007: 115-18). Dances at the village squares, held almost every Sunday, ceased in this new context, so there were no longer many opportunities for singing and transmitting the song repertoire.

Moreover, the rise of professional singers, who were usually members of the clarinet-led ensembles, along with the diffusion of amplified sound beginning in the 1970s, contributed to the transforming of village festivals. While villagers had a more participatory role in the past, they became more passive in the new context.
Furthermore, the use of microphones contributed to the formation of a different sound aesthetic. Singers were not compelled to sing loudly any more; they could sing with a more ‘velvet-like’ voice, which was the dominant aesthetic through the radio and the recording industry.

These abovementioned elements resulted in the alienation of post-war generations from pre-war aesthetics. That was why we investigated these vocal techniques almost exclusively among elderly informants. However, some vocal techniques survived the newly established aesthetic. These are mainly the low-pitched grunt at the beginning of phrases and the high-pitched tones, although they are now used less frequently. This survival is regarded as reminiscent of the old way of singing.

**Acoustical Analysis**

In order to examine similarities between *gaida* music and the singing voice from a more objective and detailed point of view, acoustical analysis was performed on selected musical pieces. These data provide results in terms of measurable musical properties (pitch, amplitude, spectra) and can be used for statistical analysis.

**Data collection**

Acoustical analysis of the *Research Programme “Thrace”* corpus is still in progress, due to the large scale of the corpus. The aim of the current study is not to present statistical data from the entire archive, but rather to point out characteristic techniques and similarities gleaned from a small subset of the analyzed archive. The choice of *gaida* pieces was random, since all pieces basically present the same techniques. The choice of songs was more defined, since, as discussed above, not all singers use these techniques.

Four different *gaida* pieces, by three different players, coded as Md007_13, Md084_11, Md108_1b, Md109_2, were selected from the database of the *Research Programme “Thrace”*. Four songs of four different singers, two female and two male, were chosen from the same database, coded as Md091_11, Md16_20, Md012_19, Md015_15 respectively. All recordings took place in the performers’ hometowns in Thrace, in non-anechoic rooms, using close microphone technique, with one or two (in case of *gaida* recordings) AKG C460B microphones with C61 cardioid capsule, and a Tascam DA-P1 DAT recorder, in 44.100 Hz s.r. We also conducted recordings with a fifth female singer, in an anechoic studio, using one Rode K2 microphone and a Yamaha AW16G recording at 44.100 Hz s.r. During the performance, a Field Electro-Laryngograph by Laryngograph LTD was used, in order to register the vocal folds’ motion. A pair of electrodes was positioned on the player’s neck, in front of the wings of the thyroid cartilage, and connected to laryngograph’s main body. The laryngograph produced a signal, which was recorded in synchronization with the
signal from the microphone. This signal, displayed as a graph of amplitude vs. time, is known as an EGG graph (electro-glotto-graph) and provides valuable information regarding the behavior of the vocal folds during a phonation (Titze 1994, Sundberg 1987). Two pieces, coded as S_4 and S_10, were chosen for presentation.

Analysis agenda

The acoustical analysis of the chosen pieces focused on examining three main features for both gaida and the singing voice: ornaments, vibrato, and timbre – register characteristics. All levels of analysis were performed using PRAAT v.4.4.34 software, specially designed for computer phonetic analysis, developed by P. Boersma and D. Weenink from the Institute of Phonetic Sciences, University of Amsterdam. Various analytical methods were employed, depending on whether a specific technique under investigation was found in gaida music or singing. With gaida music, pitch contours and spectrograms were extracted to present the various ornaments. Spectrograms, together with pitch and intensity contours, were applied to vibrato techniques. For timbre and register characteristics, spectrograms, spectra and spectrum envelopes (LPC method, 14 KHz sampling frequency, same duration for all notes) of isolated notes were also used. For the singing voice, in addition to spectrograms and intensity – pitch contours, Long-Term Average Spectra (LTAS) and EGG graphs provide valuable data (Titze 1994, Sundberg 1987).

Results

Ornaments

A. Gaida ornaments
In all pieces examined, two main ornament techniques are used: high articulation and low articulation (Levy 1985: 299, 293). In high articulation, a brief skip to the highest note of the chanter is performed, while in low articulation a brief skip to the lowest note is performed. High articulations are used within the melodic line (Fig. 6), during note repetition or at the end of a phrase (Fig. 7). Low articulations are primarily used during note repetition and whenever a pause effect is required (Fig. 8).
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Figure 6. Pitch contour and spectrogram of a high articulation gaida ornament.

Figure 7. Pitch contour and spectrogram of repeated note gaida articulation.

Figure 8. Pitch contour and spectrogram of end-note low pitch gaida articulation.
B. Singing ornaments
In all songs examined, two distinctive ornament techniques are found: High-pitched tone skips, acting as aciaccaturas, and low-pitched grunts. The first are used within the melodic line (Fig. 9, Audio sample 9, Fig. 10, Audio sample 10), during note repetition or at the end of a phrase (Fig. 11, Audio sample 11), while the second occurs at the beginning or at the end of a phrase. The high-pitched tone skip is performed either with a glottal stop (Fig. 9) or without one (Fig. 10), depending on the singer. The spectrograms reveal the timbral changes during the tone skips (differences in the grey-white pattern). In Fig. 12 (Audio sample 12) the beginning of a phrase with a low-pitched grunt is shown. The grunt may be a voiced (i.e. produced by glottal oscillations) or an unvoiced sound, as illustrated by the EGG graph. The sinusoidal patterns in the EGG graphs from the circled areas reveal that the grunt (first circle) is a vocalized sound, followed by a glottal stop. It is produced with different vocal fold behavior in comparison with the following unvoiced melody note (second circle), where the sinusoidal signal differs in shape. The male singer also performs these techniques, as shown in Fig. 13 and Fig. 14. Tone skips occur here without glottal stops.

Figure 9. Pitch contour and spectrogram of high pitch voice ornament with glottal stop. Female singer.
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**Figure 10.** Pitch contour and spectrogram of high pitch voice ornament without glottal stop. Female singer.

**Figure 11.** Pitch contour and spectrogram of high pitch end-note voice ornament. Female singer.
Figure 12. Pitch contour, spectrogram and EGG graphs of starting grunt note with glottal stop. Female singer.

Figure 13. Pitch contour and spectrogram for high pitch end-note voice ornament, with vibrato. Male singer.
Vibrato

A. Gaida vibrato
As discussed previously, two kinds of vibrato are used in gaida performance: pitch vibrato and pulse vibrato. In Fig. 15 pitch – intensity contours and spectrogram for pitch vibrato on C#5 are shown. Pitch and intensity variations are relatively small and without phase shift. In fact, one can observe that the pitch periodically reaches a higher value from a lower baseline, rather than oscillating around a mean value. The spectrogram reveals noticeable timbral differences between the two states.

In Fig. 16 similar diagrams for pulse vibrato on E5 are shown. In this case, the pitch oscillates sinusoidally around 627 Hz, while the intensity variation is more irregular. Timbre variation during vibrato is less obvious.
B. Singing vibrato

Interesting results come up when analyzing vibrato in our song samples. In most cases, pitch variations are observed in almost every sung note, but these variations differ from vibrato as it is realized by professional western ‘bel canto’ and opera singers. For the latter, pitch variation is controlled in great detail by the singer in terms of scale and periodicity, resulting in a uniform, strictly defined and constant vibrato, as shown in Fig. 17 (Audio sample 13). Fig. 18 (left) (Audio sample 14) shows a typical pitch variation for a note in the middle of a melodic phrase sung by a Thracian singer. Pitch and intensity variation is marked, but is irregular and looks more like jitter and shimmer. The same contours occur for many notes inside the melodic line. The picture is slightly altered when examining the final note of a phrase, Fig. 18 (right) (Audio sample 15) shows such a case. Pitch variation is more periodic here, especially at the end of the note. For the male singer, Fig. 19 (left) (Audio sample 16) vibrato on a note in the middle of the melody line is more jitterish, while in Fig. 19 (right) (Audio sample 17), vibrato at the end of the phrase is more regular.
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Figure 18. Pitch–intensity contours for note inside the melodic line and for note at the end of a melodic line respectively. Jitter and vibrato are evident. Female singer.

Figure 19. Pitch–intensity contours for note inside the melodic line and for note at the end of a melodic line respectively. Jitter and vibrato are evident. Male singer.

Timbre – registers

A. Gaida timbre – registers

When playing a note on the gaida, both the note and the tonic from the drone are heard. Thus, the spectrum of the sound produced is composite and contains the harmonics from the chanter and the drone. In Fig. 20 spectra and spectral envelopes are shown for four notes on the same gaida. Notes A4 and E5, said to be on the high register of the gaida, show envelope peaks in high frequencies (over 4 KHz), giving a strident color to the sound. Below A4, the low register begins and G4 indeed reveals a lower peak over 4 KHz, than A4. E4, the lowest note of the chanter, shows a steeper slope in high frequencies, and poorer spectral energy throughout the frequency range.
Figure 20. Spectra and spectral envelopes for 4 different gaida notes.

B. Singing timbre – registers

For three female and two male singers, Long-Term Average Spectra (LTAS) and trend lines are seen in Fig. 21. Though they refer to different songs recorded in different conditions, they provide valuable information. The spectral peaks around and over 2000 Hz characterize the ‘open throat’ strident color that Rice 1997 notes.

The typical high-pitched, sharp voice found in villages of the Evros region is of great interest. In Fig. 22 spectra and spectral envelopes are shown for four notes from a single female singer, from a single song. In all cases, the first harmonic is not the prominent one, while formants in high frequencies are evident. One should note the formants formed for different vowels on the same pitch and for the same vowel on different pitches. An interesting phenomenon is that at many points in the song, the lyrics ask for an /o/ vowel, while the singer produces an /oa/ vowel, as shown in the first graph of Fig. 22 (Audio sample 18). We are not sure if this is a linguistic issue, but it should be noted that the second harmonic of the tonic (Bb4) lies around 900 Hz, in the same region where the first formant of the /a/ vowel and the second formant of
the /o/ vowel are formed. Vowel change is a common issue for classical sopranos who are trained to use resonance tuning in order to avoid such problems, but it is only observed for pitches greater that 1000 Hz (Joliveau, Smith, & Wolfe 2004). In any case, /a/ vowels have higher frequency components than /o/ vowels (on the same pitch) and the tendency to sing /o/ vowels as /oa/ supports the sharp, strident color of the voice.

**Figure 21.** Long-Term Average Spectra (LTAS) and trend lines for three female and two male singers.
Conclusions

Analysis of recordings in the Research Programme “Thrace” archive revealed resemblances between gaida music and specific singing techniques in Thrace. Insights were gained by examining this issue from both ethnomusicological and acoustical approaches.

Ornaments in specific patterns are found in both gaida music and singing, although ornaments in gaida playing occur more often and with wider variations than in singing. Glottal stops often help singers perform such effects. Vibrato is more evident
in gaida music than in singing, while glottal stops are commonly observed as an integral aspect of vocal technique.

It is our belief that singers use jitter to imitate the fast trills, tone skips and melodic transitions of the gaida, effects that offer a constant pitch-shifted flow in music. The use of vocal pitch variation techniques such as jitter, shimmer, and vibrato, in conjunction with rapid tone skips and glottal stops, all function in this manner.

As far as gaida and voice registers are concerned, we believe that singers place their voice in a way that imitates the high-register timbre of the gaida. In this high register, timbre is rich in high-frequency formants, there is a characteristic sharp, strident voice color, and songs are sung loudly. Higher harmonics are often more prominent than the fundamental. In some cases corresponding vowel changes are observed. Additional research is necessary in the field of voice analysis, including formant analysis, glottal fold, source filter, and vocal path behavior, along with other widely used methodologies (e.g., presented by Sundberg 1987, 2001; Thalén & Sundberg 2001; Titze 1994).

The vocal techniques described here were in use mainly by elderly informants, who grew up in the social context of the old, agricultural societies. Our informants did not conceptualize them as something specific, but rather as an inseparable part of their singing. We believe that, apart from the technical similarities observed between vocal techniques and those of the gaida, one can investigate a past music environment completely different than the contemporary one. In the pre-WWII context, you had to sing loudly in order to be heard in a noisy village square, and there was also a need for continuous sound to keep the dance going. Both men and women had to meet that challenge: women with their singing, and men with the gaida. The outcome seems identical, because the conditions were the same.

Unfortunately, we are unable to answer a basic question: has singing influenced gaida technique, or has the gaida informed singing with its techniques? To quote Racy (1994: 38):

“...musical instruments are interactive entities. Being both adaptive and idiosyncratic, they are not mere reflections of their cultural contexts, nor are they fixed organological artifacts that can be studied in isolation from other social and artistic domains. Instead, instruments interact dialectically with surrounding physical and cultural realities, and as such, they perpetually negotiate or renegotiate their roles, physical structures, performance modes, sound ideals, and symbolic meanings.”

In this way, we propose that the gaida and the singing voice are, for the agricultural societies of Thrace, ‘two sides of a single coin’.

In this way, the prospective singer or scholar working with this repertoire must seriously consider the social context within which that music was enacted. We believe that, in doing so, the songs will certainly reveal their ‘mystery’.
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References


1 *Research Programme “Thrace”* (1995-2004) was an inter-disciplinary project of the Lilian Voudouri Music Library of Greece, dedicated to the research of the music tradition of Thrace and Eastern Macedonia provinces of Northern Greece. A large multimedia database was developed, where music recordings, interviews, photos and videos were stored. Access to the database is free after subscription, follow URL: http://epth.sfm.gr

2 Cross fingering is the act of closing further holes downstream from one open hole of an aerophone.