

# *Eridanos* by Iannis Xenakis: An Analytical Approach\*

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*Eridanos*<sup>1</sup> was written in 1972 for 60 string instruments (16, 14, 12, 10, 8) and brass (2 tubas, 2 trombones, 2 horns and 2 trumpets). The score features no woodwind nor percussion instruments. And contrary to other orchestral pieces by Xenakis, each string instrument does not play an individual part. First violins, second violins, violas, cellos and double basses are simply divided into two groups.

Perhaps one of the most striking features of *Eridanos* is the absence of glissandi, considering that it was composed just after Xenakis had used random-like melodic contours<sup>2</sup> and just before he developed the idea of arborescence, which relies mainly on continuity as one of its main characteristics. In this context, *Eridanos* appears as if given in parentheses.

Xenakis said very little the work. He did not mention it in his writings nor in his main interviews. The only sources of information available are the notes to the score and files found in the Xenakis Archives on deposit at the Bibliothèque nationale de France.<sup>3</sup>

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\*This is an excerpt from a paper presented at the *Iannis Xenakis. In Memoriam International Conference*, Nicosia, 3-5 November 2011 at the European University Cyprus.

<sup>1</sup>*Eridanos* (1972) for orchestra, duration 11', Éditions Salabert.

<sup>2</sup>Xenakis used random-like melodic contours in his instrumental music by transposing the waveforms obtained in sound synthesis with the help of probability functions [see Xenakis, 1992, pp. 242-254]

<sup>3</sup>I should like to thank Françoise and Mâkhi Xenakis for allowing me to access the Xenakis Archives. I am also grateful to Marie-Grabelle Soret and her colleagues from the music department at the *Bibliothèque nationale de France* for their helpfulness.

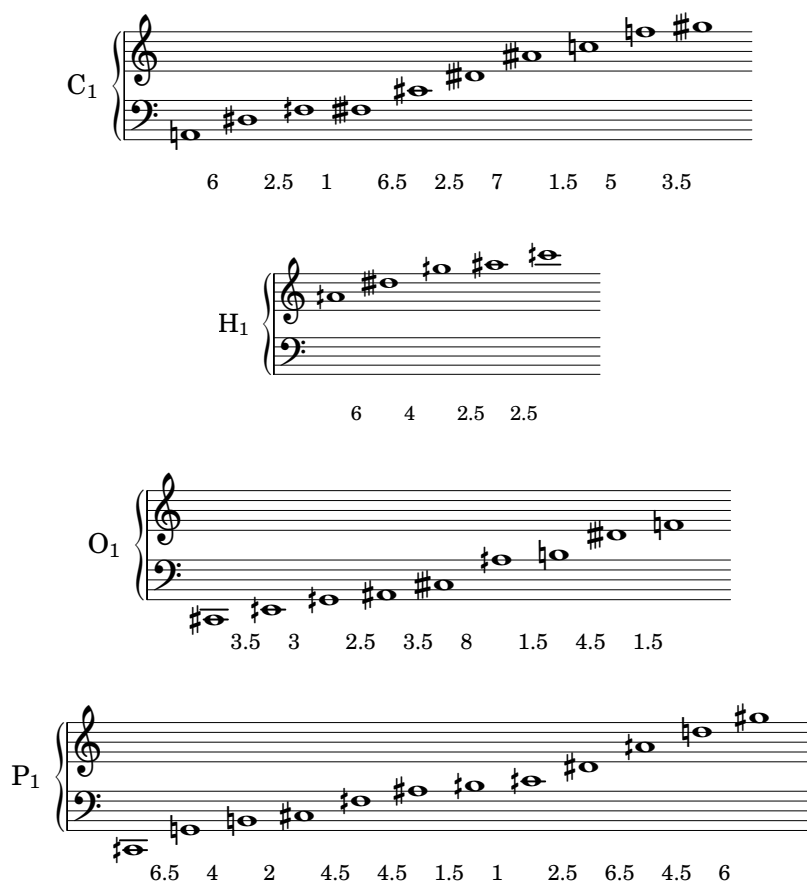


Figure 1: Series of intervals (quarter-tones) associated with Carbon (C), Hydrogen (H), Oxygen (O) and Phosphorous (P) elements.

In the notes to the score, Xenakis refers to *Eridanos* as the name of an ancient river of Athens and of a constellation in the southern hemisphere. *Eridanos* also means “quarrelsome”. But Xenakis’ main inspiration was the image of a polynucleotide genetic chain.

In *Eridanos* pitch organization relies on four sets of intervals associated with four chemical elements: Carbon, Hydrogen, Oxygen and Phosphorus. A close analysis of the score reveals that these sets consist of series of intervals as shown in Fig. 1.

The Carbon element comprises 9 intervals, the Hydrogen, 4; the Oxygen 8 and the Phosphorus, 10. For most of the piece, the unit length is set to a quarter-tone. If we except the Hydrogen element, which comprises only five pitches, the intervallic structures of the other elements are similar and share common characteristics. The intervals vary between one and eight semitones, and within the compass of each

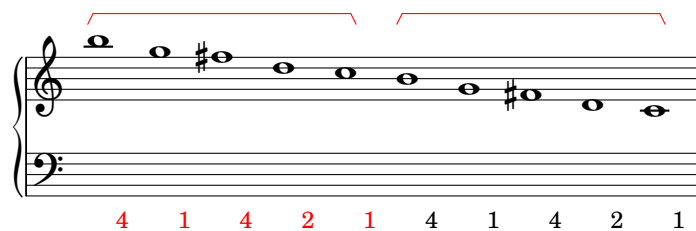


Figure 2: “Bali” scale.

set, the mean interval varies between 3,5 and 3,95 (3,94 (C), 3,75 (H), 3,5 (O) and 3,95 (P) semitones.

What is interesting about the structure of the Carbon element is that Xenakis seems to have derived it from a Balinese scale. A document found in the Xenakis Archives<sup>4</sup> shows a scale with the indication “Bali” (Fig. 2).

In Xenakis’ terms, it is an octaviating scale, that is, its intervallic structure repeats itself at the distance of an octave. It is also characterised by an interlocking of two fourths, represented by a succession of one and four semitones. Xenakis later related this intervallic structure to the *Pelog*. We know from Xenakis’ interview with Balint Varga Varga [1996, p. 144], that to elaborate the sieve of *Jonchaies*<sup>5</sup> Xenakis did not rely on a mathematical expression but drew on Javanese music, in particular on the *Pelog*. The melodic patterns associated with the *Pelog* pervade much of Xenakis’ sieves, particularly at the beginning of the 1980s. In the notes to the score of *Komboï* for harpsichord and percussion, Xenakis refers to the *pelog* as: “a kind of antipode of the diatonic scale of the white notes of the piano.”<sup>6</sup>

How did Xenakis derive the Carbon element from this original scale? Other examples sketched on the same document suggest that Xenakis carried out a series of transformations before finding the right intervallic structure for the Carbon element. First, Xenakis changed the elementary displacement unit to 1.5 semitones. Then, perhaps in order to avoid a periodic structure, he manually distorted the structure of the scale and permuted the intervals until reaching a satisfactory distribution for the Carbon element.

The sets of intervals used by Xenakis in *Eridanos* foreshadow the idea of sieve developed by the composer in his theoretical writings [see Xenakis, 1992, pp. 268–276]. They are a means of defining the outside-time structure of pitch in a way similar to what sieves will achieve in his later pieces. The main difference being

<sup>4</sup>Xenakis Archives, Dossiers Œuvres OM 36/12.

<sup>5</sup>*Jonchaies* (1977) for orchestra, duration 17’, Éditions Salabert.

<sup>6</sup>*Komboï* (1981) for harpsichord and solo percussion, duration 17’, Éditions Salabert.

The image shows a musical score for measures 201-203 of the piece *Eridanos*. The score is arranged in a system with ten staves. The instruments and their parts are as follows:

- Hn (Horn):** Bass clef, starting at measure 201. Dynamic *p*. Articulation *flatt. →*.
- Trpt (Trumpet):** Treble clef, starting at measure 201. Dynamic *p*. Articulation *flatt. →*.
- Tb (Tuba):** Bass clef, starting at measure 201. Dynamic *p*. Articulation *flatt. →*.
- Tu (Trombone):** Bass clef, starting at measure 201. Dynamic *p*. Articulation *flatt. →*.
- VI (Violin I):** Treble clef, starting at measure 201. Dynamic *f*. Articulation *tremolo →*.
- VII (Violin II):** Treble clef, starting at measure 201. Dynamic *f*. Articulation *tremolo →*.
- A (Viola):** Bass clef, starting at measure 201. Dynamic *f*. Articulation *tremolo →*.
- Vc (Violoncello):** Bass clef, starting at measure 201. Dynamic *f*. Articulation *tremolo →*.
- Cb (Contrabass):** Bass clef, starting at measure 201. Dynamic *f*. Articulation *tremolo →*.

The score is written in a key signature of one sharp (F#) and a time signature of 4/4. The brass instruments play a rhythmic pattern of eighth notes, while the strings play a tremolo pattern of eighth notes. The dynamics range from *p* (piano) for the brass to *f* (forte) for the strings.

Figure 3: *Eridanos*, b. 201–203.

that sieves extend over the whole range of the frequencies, whereas sets of intervals are confined in a limited register.

In *Eridanos*, Xenakis does not always use all the intervals of a set. Variation of density is also one of *Eridanos*' main characteristics. Xenakis often chooses subsets or even single notes to represent an element. A good example of this is found near the end of *Eridanos*, the strings and the brass focus on three notes only, played within an interval of a minor third, but that belong to two different sets: Oxygen 8 and Phosphorus 5. Both sets are intertwined and are only differentiated on the basis of instrumentation (Fig. 3).

There are also cases where Xenakis adds pitches progressively. The beginning of *Eridanos* is based on the first Carbon element. Xenakis starts from a single

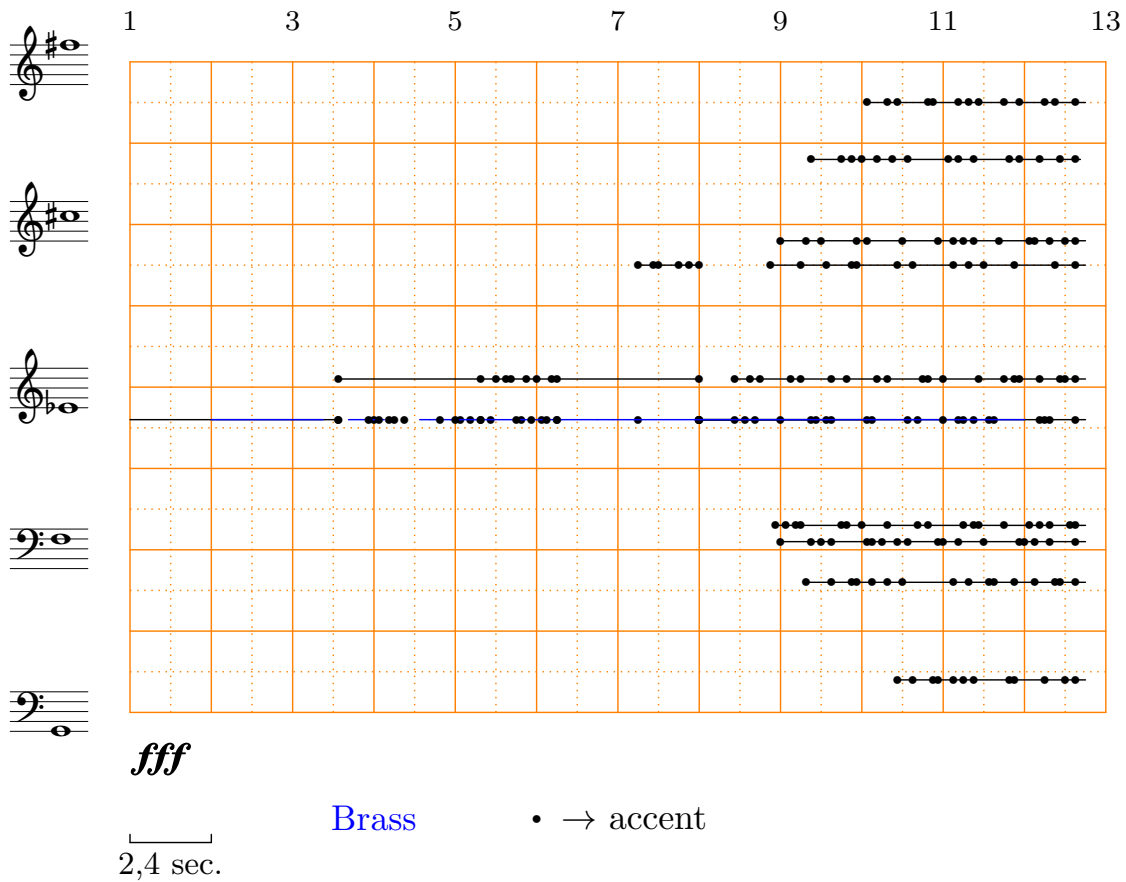


Figure 4: *Eridanos*, bars 1–12: graphic representation.

note, then gradually increases the density on either side by adding horizontal lines punctuated by accents. This opening gesture is to some extent similar to the opening of *Metastaseis*<sup>7</sup>, where series of glissandi branch out from a single root.

In the Xenakis Archives, in the same folder, there are small strips of paper that probably functioned as rulers to help Xenakis draw the intervals associated with each set (Fig. 5). The intervals of two different sets are indicated on the left and the right side of each ruler. By rotating them, Xenakis can use one or the other. It should be noted that reading the opposite side, however, would align the intervals in inverse or retrograde form. In *Eridanos*, this happens only once, with a Carbon element [b. 47-50]. It may not have been intentional.

As practical tools, these rulers facilitate the use of transpositions. By moving them up and down, Xenakis can move the sets in different registers; by moving them

<sup>7</sup> *Metastaseis* (1954) for orchestra, duration 10', Boosey & Hawkes.

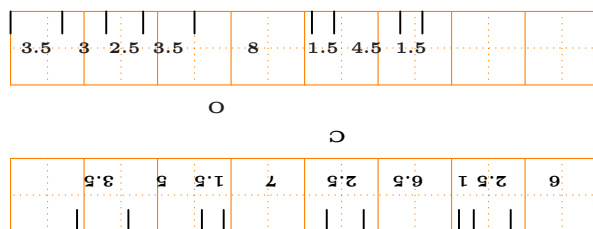


Figure 5: Ruler corresponding to the Carbon (C) and Oxygen (O) elements.

horizontally, he can determine the duration of each set at will. Rulers also provide a suitable way to combine various elements. There are passages of greater density where Xenakis superimposes various transformations of the same set.

In the notes to the scores, Xenakis also refers that “the elements are presented by means of fixed sets of intervals which permutate”. The Carbon element consists of 9 intervals, two of which are repeated. This means that there are 181,440 possible different arrangements of these intervals ( $9!/2!$ ). But during the course of the work, Xenakis uses only 5 different permutations. Overall, Xenakis selects a total of 23 different sets: five Carbon, five Hydrogen, five Phosphorous and eight Oxygen elements.

The main forms used by Xenakis in *Eridanos* are described as clouds or meanders, to which we could add blocks of individual lines, which can vary from one to 12 notes. The opposition clouds/meanders or blocks relies mainly on the how pitches are distributed among the instruments. Blocks are played as a layering of lines of relatively fixed pitches (see Fig. 4), whereas meanders are deployed on various pitches as if creating melodic lines. The idea of meanders results from the fact that in his graphic representation of *Eridanos*, Xenakis draws vertical lines between sustained sounds (Fig. 6). It should be said that similar passages in Xenakis’ earlier or even later works often appear without vertical lines between the pitches, except perhaps in *Cendrées*<sup>8</sup>, which was written the following year. As for clouds, they are associated with the Hydrogen element played pizzicati by the strings.

How does Xenakis relate the elements of *Eridanos* to polynucleotide genetic chains? Nucleotides are molecules that, when joined together, make up the structural units of RNA and DNA. They are composed of a nucleobase (nitrogenous base), a five-carbon sugar (either ribose or 2’-deoxyribose), and one phosphate group. Bars 89–96 of *Eridanos* display successive combinations of permuted Carbon, Oxygen and Hydrogen elements separated by pauses. Here, the Carbon elements assigned

<sup>8</sup>*Cendrées* (1973) for mixed chorus and orchestra, duration 25’, Éditions Salabert.

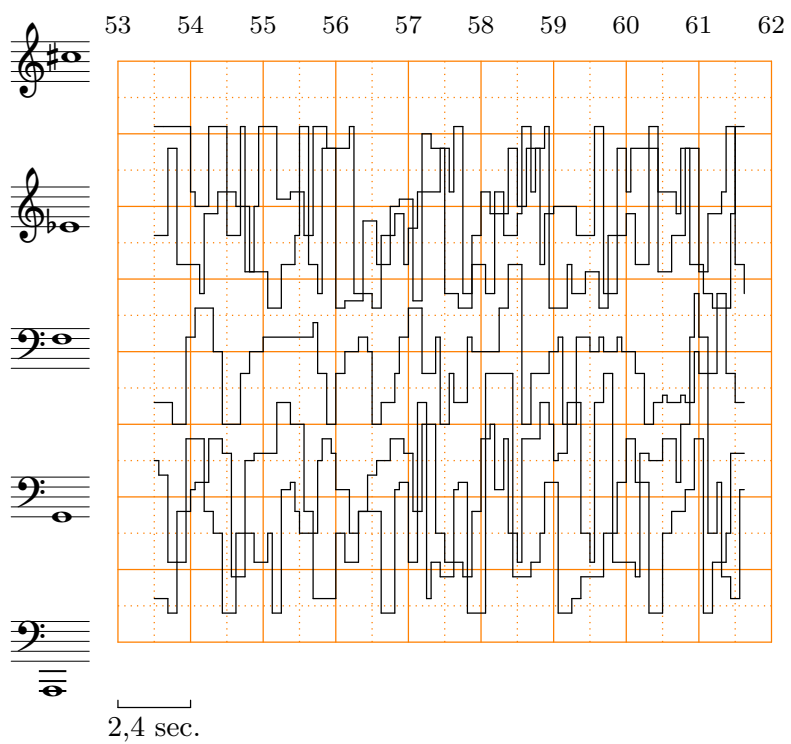
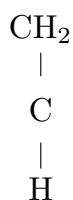


Figure 6: *Eridanos*, bars 53-61, strings tremolo: graphic representation.

to the brass are barely audible owing to the fact that Xenakis requires them to play “ghost sounds with the breath”. Then the strings play “Phantom sounds”. They are required to bow the box of the instrument. The third combination of elements is different. Xenakis assembled two Carbon elements and two Hydrogen elements, one of which is duplicated in a lower register. The disposition of the elements in the score could be represented as follows:



The highest register contains the fifth Carbon and two Hydrogen elements. Xenakis transposed the higher fifth Hydrogen element two and a half semitones down. The middle register comprises the fourth Carbon element. As for the lowest register, it is assigned to a transposition of the fifth Hydrogen element.

On the basis of this analogy, we can relate the elements of *Eridanos* to a five-carbon sugar attached to a phosphoric acid (Fig. 7). In the first part of the piece, Xenakis uses Oxygen, Carbon and Hydrogen elements only, whereas in the second part, he combines Oxygen and Phosphorus elements. This corresponds to the distinction between a five-carbon sugar and a phosphorus group. Besides, by means of permutations, Xenakis generates five Carbon and five Hydrogen elements, in agreement with the number of these elements in this fragment of DNA.

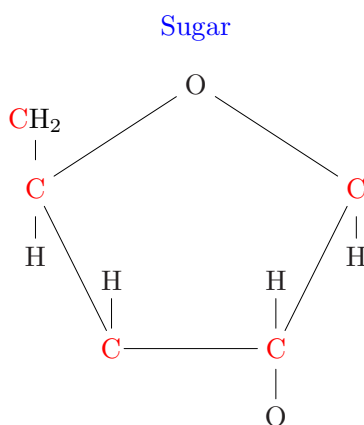


Figure 7: DNA structure of a 5-Carbon sugar.



There are theoretical documents<sup>9</sup> in the Xenakis Archives, written in Greek, suggesting that Xenakis intended to develop further the analogy with the genetic code of the DNA structure. In these documents, the composer expounds theoretical principles similar to those he had developed in *Nomos Alpha*<sup>10</sup>, mapping parameters onto the vertices of polyhedra and associating them with permutation groups [See Xenakis, 1992, pp. 201–241].

But in the end, Xenakis seems to have limited himself to create sets of intervals and simple forms that he could modify by coordinating contrasting distributions of density, playing techniques and dynamics profiles. As is often the case, Xenakis prefers to shape and modify the sound by simple means, as a sculptor.

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<sup>9</sup>Xenakis Archives, Dossiers Œuvres OM 36/12.

<sup>10</sup>Nomos Alpha (1965) for solo cello, duration 15', Boosey & Hawkes.