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# SOMMARIO

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# MUSIC AND PHONETICS IN MAGNA GRAECIA

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## INTRODUCTION

ANY investigation into the achievements accomplished by the ancient Greeks in acoustics needs to start off with the development of the Pythagorean theory of music with special reference to the relations between music and mathematics which this theory establishes. Indeed, interest in acoustic phenomena developed in ancient Greece in connection with the musical doctrines of Pythagoras and his disciples and successors. In addition, much more than bare indications has allowed me to infer that the results of Pythagorean research into this field were applied to speech sounds. Pythagorean musical research is therefore presupposed by the study among the ancient Greeks of the acoustic phenomenology of the human voice and the physiology of the organs serving the purpose of producing it.

As an example, certain reflections on the Greek accent may be mentioned to prove this point. The Greek accent may in fact be described as consisting in a particular intonation given to a tonic vowel and, as Dionysius of Halicarnassus explicitly affirms in his work *On the Composition of Sentences*,[1] when provided with an "acute" accent a vowel was characterized by a rise in the pitch of the voice equivalent to the interval of a fifth in comparison with the neighbouring unstressed vowels. The Greek terms associated with the notion of accent bear some reference to music. This is true for προσωδία «accent», ὀξύς «acute» and βαρύς «grave», while the term τόνος will assume the acceptation «accent» from the previous technical meaning of «interval between two contiguous notes» with which it was used in the Pythagorean circle. *Pythagoras* and his followers must have derived it on their own from the basic idea of stretching conveyed by the root τεν-, which τόνος is related to,[2] and applied to a musical string. Analogously, the musical origin of some concepts of grammar appears certain. This is the case with the notion of consonant expressed by the Greek term σύμφωνον.[3] As a technical term of music employed by the Pythagoreans, the adjective σύμφωνοι is the opposite of διάφωνοι and qualifies two simultaneous musical sounds producing a unitary auditory sensation, viz constituting some consonance, while consonance itself is named συμφωνία. As it is the name of a consonant as an element of speech, σύμφωνον is likely to have originated from the musical notion of συμφωνία and therefore from the idea of sounding together in harmony within a syllable.

It is not, however, easy to translate the Greek word συμφωνία in English owing to

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[1] XI,58.

[2] Of course, the noun τόνος exhibits an apophonic degree different from that of τεν-, on which the verb τείνω (< *τέν-jω) is based.

[3] The term σύμφωνον appears to have been used by the Stoics and is also found in the Τέχνη γραμματική, the only treatise on grammar handed down to us by ancient philology. Aristotle employed the term ἄφωνον instead. A tentative interpretation of the seeming substitution of σύμφωνον for ἄφωνον is given by BELARDI 1985, p. 71, note 72.

the technical circumscription undergone in the language of modern musicologists by the terms chord and consonance, that will be alternatively used to translate it. As a technical word, nowadays a chord means a simultaneous combination of three or more notes which joins no fewer than two superimposed thirds,[1] but in English usage, both current and past, the word chord may also mean a combination of two or more notes sounding together in harmony.[2] Further, in modern music terminology the word consonance refers to the qualitative evaluation of both intervals and chords.[3] The musical meaning of consonance today is therefore wider than that which will be given to it by employing the word consonance to render the Greek noun συμφωνία.

Consistently with current terminology, συμφωνία might also be translated «harmonic interval, consonant and simple», a circumlocution in which «harmonic» ought to refer to the simultaneity, «consonant» to unitary impression and «simple» to the limitation to only one octave. I have preferred to translate συμφωνία as consonance so as to maintain the distinction between the two Greek terms συμφωνία and διάστημα. It is this second term which denotes the interval regarded as both the «distance», i.e. the proportion of a measurement of one length to another, and the «differs in pitch» between two different notes. In Greek musical texts this term referred to a tone, a semitone and similar as well as to an octave, a fourth or a fifth.

Thus, according to the first Pythagoreans, each and every συμφωνία is also a διάστημα, but the contrary is not true, for an interval such as either a tone or a semitone does not bring about a unitary impression of hearing. On the other hand, the English word *consonance* derives from Latin where *consonantia* is to be found as a rendering of συμφωνία for the first time in texts going back to the 3rd century AD.

In the course of my argument, however, when designating an octave, a fourth, or a fifth I have allowed myself to alternate the renderings «consonance» and «interval» depending on whether mention is made of their audible counterpart or the relation between notes of different pitch is in particular alluded to. Of course, my account will be conjectural, as it normally is when one does not have access to the original works of the authors investigated. It could also be considered an incomplete exposition, in that much more information on the whole Pythagorean system of reasoning about man and the world he lives in could have been added and its relation with what is being discussed could have been further investigated, but here I preferred to concentrate solely on those aspects that dealt more and best with our subject.[4]

## From Music to Phonetics

While reasoning on the impossibility that numbers are the cause of things, Aristotle recalls the belief of Pythagorean ascendance according to which ξ, ψ, and ζ are consonances, συμφωνίαι. He precisely says:[5]

[1] See the entries «chord» and «consonance» in Sadie-Tyrrel 2001.

[2] See the entries «chord» and «consonance» in Simpson-Weiner 1989.

[3] This rendering was justified by a more ancient usage according to which the Greek συμφωνίαι of an octave, a fourth, and a fifth were called perfect consonances. See Sadie-Tyrrel 2001.

[4] My argumentation presupposes the reading of a vast bibliography which in a few rare cases has been called into account throughout the following pages and has been cited at the end of the paper. As to the pre-Socratic philosophers the key source of reference is the collection of fragments and comments of other Greek and Latin authors collected by Diels and Kranz (Diels-Kranz 1985[6]).

[5] *Metaphysics*, XIV, 6, 1093a, 20-26.

and yet they even say that ξ, ψ, and ζ are consonances and that because there are three consonances, the double consonants are also three. It is not important that there might be countless such letters; for one symbol might be assigned to γρ. But if they say that each of these three is twice of the other single letters, and no other is so, and if the cause is that there are three places (viz in the mouth) and in each one a voice-part is applied to σ, it is for this reason that there are only three, not because the consonances are three; for as a matter of fact the consonances are more than three, but of double consonants there cannot be more.

The values of the Greek φωνή which correspond to the elements indicated by these signs of writing are three, because the possible consonances are in fact three. Without considering the confutation of the supposed causal relationship between the number of consonances and the number of the so-called double consonants or Aristotle's position thereon, this fact is important for two different reasons: first it denotes the Pythagoreans' broad interest in linguistics, and second there appears to be a term of unequivocal musical ascendance applied to linguistic notions. The doctrine cited is surely ancient-Pythagorean, which identifies three consonances: an octave, a fifth and a fourth. The old-school Pythagoreans reached these conclusions rationalizing the intervals of octaves, fifths and fourths in mathematical terms, and the numerical foundation was given by the ratios 2:1 (=12:6), 3:2 (=12:8), and 4:3 (=12:9) respectively, and thus holding true that the numbers 1, 2, 3 and 4 constitute the natural series which makes up the τετρακτύς.[1] This figure had been sacred to the Pythagoreans since before the schism of the Akousmatic and Mathematical schools.[2] Furthermore, evidence is given in favour of the rationalization in numerical relationship of the consonant intervals before the split. As a matter of fact, this rationalization is traditionally attributed personally to Pythagoras. Within this tight-fit network of relationships of musical theory, arithmetic, geometry and metaphysics of number established by the Pythagoreans, a direct interdependency between a philosophic and scientific investigation of music and a linguistic analysis is properly perceived. Clear emphasis is given to the consideration of graphical order that the peculiarity of representing the consonances, proper to those which are conventionally called double consonants, would be proved by the fact that these are written with a single sign.[3] Thus a highly meaningful coincidence is stressed: there are three double consonants because they represent consonances, which are three. The information given in the comment on the passage of *Metaphysics* cited above and written by Ps.-Alexander of Aphrodisias is also without a doubt of interest:[4]

moreover, they (viz the Pythagoreans) also say that the double consonants are three – ζ, ξ, and ψ – because there are three consonances as well, and they try to trace back each of the first to each of the consonances: ζ to the fourth, ξ to the fifth and ψ to the octave.

[1] As is well known, the original *tetraktys*, that by which the Pythagoreans swore, was the «*tetraktys* of the dekad» and represented the number ten as the triangle of four (DIELS-KRANZ 1985[6], XLIV, A1, 58 B15).

[2] Quite little is known about Pythagorean activity during the latter part of the V century. The differentiation of the school into two main sects, later called «acousmatics» and «mathematicians» (DIELS-KRANZ 1985[6], XVIII, 2), may have occurred at that time. The acousmatics devoted themselves to the observance of rules and to the interpretations of the sayings of the master; the mathematicians were concerned with the scientific aspects of Pythagoreanism.

[3] As is well known, a single sign for each of the so-called double consonants was in use in the so-called red alphabets much before 403/402, when upon Archinus' proposal the orthographic reform was adapted and given the name of Euclidean from the archon Euclid. Cfr. CIANCAGLINI 1996, pp. 105-110.

[4] HAYDUCK 1891, p. 833, 2-5.

Therefore, the Pythagoreans had gone as far as speculating that ζ corresponded to the fourth consonance and ξ and ψ respectively to the fifth and octave. The same fact is mentioned in the comment of *Syrianus* on the same passage of *Metaphysics*: [1]

> still concerning double consonants ζ, ξ, and ψ, Aristotle also says that these are not three because there are three consonances, and he says rightly: nor is it possible to trace back each double consonant to each singular consonance, that is ζ to the fourth consonance, ξ to the fifth and ψ to the octave.[2]

Here again ζ, ξ and ψ correspond to the fourth, the fifth and the octave consonances. Clearly the First Pythagorean School considered the so-called double consonant ζ as the fourth consonance. The first part which was constituted by δ, was in fact articulated – to use modern terminology – in a point of the oral tract somewhere between where the first parts of ξ and ψ were articulated.[3] The consonant ξ, whose starting point of articulation corresponds to the most interior part of the mouth, coincided with the fifth, whereas the consonant ψ, whose point of articulation is at the most exterior part of the oral cavity, corresponded to the octave consonance. It is unknown how the inquiry of the Old School of Crotona reached these conclusions. Aristotle himself seems to not know with certainty what induced the Pythagoreans to view ζ, ξ and ψ as consonances. As a matter of fact, he first examines the possibility that they were influenced by the orthography, but soon after he considers as an ulterior motivation the eventuality that their theory was based on the phonetic-acoustic observation that ζ, ξ and ψ are the only three double phones of the Greek voice, φωνή.

If the situation is in fact so, then it becomes necessary to proceed hypothetically. The course of thinking followed by Pythagoras to reach the general and theoretical classification of musical intervals, thanks to the quantification of their constant numerical ratios, is cited by Nicomachus:[4]

> while passing by a blacksmith's, by a fortunate chance he (viz Pythagoras) heard several hammers beating iron on an anvil and producing perfect consonant sounds with one another except for a couple. Thus he recognized those sounds as the consonances of an octave, a fifth, and a fourth. He noticed that the interval between a fourth and a fifth was not consonant in itself, yet in another respect turned out to be fit to fill the interval between the two. Thankful for the apparent divine help received, he entered the workshop, and after various trials he found that the difference of sound was related to the weight massed in the hammers and not in the strength of the blows, neither in the shapes of the hammer heads, nor in the transformation of the iron being forged. Once having carefully surveyed the weights and the more precise counterweights of the metals, he returned home. Then, he suspended four strings, all of equal composition, length and thickness, which were interwoven in the same manner, to a wooden peg driven perpendicularly to the wall, keeping them separate from one another, so

[1] KROLL 1902, p. 191, 24-28.

[2] *Syrianus*' use of the expression δι'ὀξειᾶν to indicate the fifth consonance, which Ps.-Alexander of Aphrodisias calls διὰ πέντε, is noteworthy. The Dorian dialectal expression δι'ὀξειᾶν is universally regarded as more ancient than the other διὰ πέντε. In a fragment by Philolaus (DIELS-KRANZ 1985[6], XLIV B6) it is used with the terms ἁρμονία and συλλαβά, which respectively refer to the octave and the fourth consonances.

[3] The value of ζ in Old Greek is disputable. However most scholars would agree that Aristotle's expression presupposes that in ζ the spirant part followed the plosive part, and likewise in the case of ξ and ψ the velar and labial respectively preceded the spirant part.

[4] *Harmonics*, VI, 11-82.

that no difference should result or be suspected because of the discrepancies in the pegs. He also attached a weight to the bottom of each of these strings [with a weight of 12, 9, 8, and 6], making sure that the lengths of the strings were absolutely identical. By alternately plucking two strings together at a time, he found the types of consonance above mentioned, one for each different pair. He realized in fact that the cord stretched by the heaviest weight produced a consonance of an octave when plucked together with the cord stretched by the lightest weight: the measurement of one of the two weights was twelve, while the other was six. So he explained that the consonance of an octave consisted in the duple-ratio [i.e. 2:1] – which the measurements of the weights themselves also revealed. Further, since the string with the heaviest weight, when plucked together with the other [with the weight of eight] next to that with the lightest weight, produced a consonance of a fifth, he was able to prove that this consonance was determined by the *hemiolion*-ratio [i.e. 3:2] – a ratio which also held between the measurements of the weights. Again, a cord with a heavier weight than the others, which weighed nine, together with the next tightest string [i.e. the cord weighing twelve], produced a fourth consonance in proportion to the weights, so he immediately comprehended that this consonance related to the *epitriton*-ratio [i.e. 4:3], whereas the same string bore the *hemiolion*-ratio to that with the lightest weight [for 9:6 is the same ratio]; in the same way the string next to that with the lightest weight, that is the string stretched with the weight of eight, had an *epitriton*-ratio to the string holding the weight of six and a *hemiolion*-ratio to the string with the weight of twelve. As for the interval between a fifth and a fourth, that is the difference by which a fifth exceeds a fourth, he established that it consisted in the *epogdoon*-ratio [i.e. 9:8]. In either way the same solution was found: an octave resulted from a fifth and a fourth in combination with one another, because certainly the duple-ratio derives from the ratio of the *hemiolion* to the *epitriton*, that is from 12, 8, and 6 [12:8 x 8:6 = 2:1], or inversely an octave resulted from a fourth and a fifth, because the duple-ratio derives from the ratio of the *epitriton* to the *hemiolion*, that is from 12, 9, and 6 in this order [12:9 x 9:6 = 2:1]. Once he had tired both his hand and his hearing with the weights and had confirmed the argument of the ratio by these means, he cleverly transformed the common transverse peg with the strings wound round the bridge of the instrument that he called 'string stretcher', he also changed the quantity of the tension connected with the weights into the corresponding quantity of coils spun round strips of leather in the higher part of the instrument. Also utilizing this device as an infallible tool of assessment, he extended his further tests to various instruments – to the clash of *kymbala* as well as to *auloi*, pan-pipes, monochords, trigons, and such-like – and in all of them he found the apprehension through ratio concordant and consistent. Then he called *hypate* («highest») the note corresponding to the number six, *mese* («middle») that associated with the number eight and in the *epitriton*-ratio to the former, *paramese* («next above the middle one») that coupled with the number nine and characterized by being one tone higher than the *mese* and surpassing it in pitch in the ratio of 9:8, and *nete* («lowest») that linked with the number twelve. He also bridged the intervals with proportional notes according to the diatonic scale. So he could relate the octachord to numbers in concord consistently with the ratios of the duple, of the *hemiolion*, of the *epitriton*, and also of the *epogdoon* as the difference between the latter two.

Pythagoras thus would have gained the general and theoretical classification of musical intervals thanks to the quantification of their constant ratios. This anecdote is without a doubt interesting and is confirmed by Iamblichus.[1] Passing by chance by a blacksmith's, Pythagoras is said to have heard harmonic sounds, all but a couple, in the octave, fifth and fourth consonances. Having entered the shop, he ascribed the

[1] *De vita Pythagorae*, XVI, 115, 6-121, 10.

difference among the single sounds to the different weights of the hammers used. Associating a number to each weight, he chanced to set precise numerical ratios among the weights of the hammers which produced defined consonances. The different weights corresponded to the sequence of the four numbers 12, 9, 8, and 6. The circumstance was certainly noteworthy, since 12, 8 and 6 coincided in the order with the numbers of the sides, the vertices and the faces of a cube, whereas 9 corresponded to the arithmetic mean between 12 and 6. Put together two by two, Pythagoras arrived at the conclusion that the consonances heard were mathematically reproducible by the following ratios: 12:6 for the octave, 12:8 or 9:6 for the fifth, and 12:9 or 8:6 for the fourth. Lastly 9:8 was consistent with a tonal interval. The ratios generally used to indicate the main intervals are obtained by the mathematical simplification of these numerical ratios: 2:1 for the octave, 3:2 for the fifth, and 4:3 for the fourth. Successively Pythagoras put to test his hypothesis. He took four strings of the same composition, length, thickness, and weave and attached them to a wooden peg hanging perpendicularly to the wall. He then attached a different weight to each string, assuring that each string was of the same length once the weight was added. The differences between the strings was regulated by the different tensions determined by the attached weights. Plucking the strings two at a time he experienced the consonances that he had heard before, thus realizing that they matched the same ratio as the weights'. His theory was creatively put to practice in what is called the monochord, a musical and scientific laboratory instrument which Pythagoras invented and taught his closest followers to use, as is reported by Gaudentius,[1] who says that he used it to determine the numerical ratios connected to the consonances:

> but notwithstanding and not satisfied with the simple research based on these [viz the hammers], Pythagoras tests the investigative method in a different manner: once a string was strung on a ruler, which is divided in 12 parts, he plucked the whole string and then half of it, equivalent to 6 parts, finding that the whole string was consonant with the half of it according to the octave consonance, the type of consonance that in the previous investigations he set in a duple ratio. Then he sounded the whole string and three parts of it, recognizing the fourth consonance. Having then plucked the whole string again and two parts of it, he found the fifth consonance and the others analogously. After having performed other tests in different ways, he found that the ratios of consonance, constantly the same, consisted in the aforementioned numbers.

Gaudentius tells that after having divided it in 12 parts, Pythagoras first plucked the whole string of the monochord, and immediately after he plucked half of it, realizing that in this way he was producing an octave consonance. The fourth consonance was sounded by the pluck of the whole string and three-fourths of it. The fifth consonance was finally produced by vibrating once again the whole string and two-thirds of it. In other string or wind instruments the length of the sound source is as important as other various factors like the tension or the thickness of the strings or for wind instruments the form, diameter and type of mouthpiece. As for the monochord the only influencing factor is the length of the string. From the cited passages it is also evident that the first experiments were conducted on instruments in which one of the primary factors was the length of the strings (in trigons) or of the pipes (in *auloi*).

[1] *Harmonic*, XI.

It seems reasonable to say that Pythagoras and his school had chiefly considered the length factor, because this was the only factor rigorously quantifiable, being a linear quantity possible to treat arithmetically.

More passages of various authors should be taken into account, but I am not allowed to write at great length. So I will switch to phonetics.

## Pythagorean Phonetic Classification of Plosives

The passages reported above suggest that Pythagoras had the invariance of the numerical ascertainment confirmed by the variety of instruments employed. If so, it is reasonably plausible that the length of the *auloi'* resonator was sectioned by means of the opening and closing of the holes along its edge according to the ratios established. The resonator of the *aulos* could have been analogously identified with the human oral tract. Its entire length up to the lips might be sectioned in twelve parts. The position of the tip of the tongue, lifted and curved opposite the upper dental arch, might correspond to six units of length.[1] With eight units, that is two-thirds of the whole length, there would be the point of articulation for the sound δ, and with 12, naturally, the place for bilabial emission. Moreover, another three units might be added to the six of the apical position to reach the posterior point, what in modern terms could be defined as the point of articulation of velar sounds[2] and identifiable with nine, equivalent to three-fourths of the whole length. Supposing that six is the apical position of the second member in each case, ψ would be produced by the ratio of 12:6 (= 2:1), ζ by the ratio of 8:6 (= 4:3) and ξ by that of 9:6 (= 3:2). If these assumptions are correct, then it would be necessary to hypothesize that the knowledge of the phonetic processes was systematically studied at least as far back as the Pythagoreans, a notion worth of reconsideration by modern scholars of Ancient Greek culture.

Considering what has been said in the preceding paragraph about the role of the mean as a parameter in establishing a correspondence between items of reality, it is not surprising that Belardi[3] affirms that dealing with the parts of the voice, Greek thinkers and grammarians make use of this tool. The hypothesis that I have proposed above demonstrates that the Pythagoreans have a clear view of the points of articulation of both stops and sibilants that form the three consonants traditionally called double. A consequent question would be how they analyzed the differences between π, τ, and κ on one hand, and respectively β and φ, δ and θ, and γ and χ on the other. The answer can be found again from the analogy with music and in particular in the way of playing the *aulos*, the most ancient form having only three holes. Depending on whether the hole was closed slightly, partially or entirely, it was possible to produce three different sounds, and precisely with the two different types of obstruction sounds lower than half or a quarter tone could be sounded. Supposing that the Pythagoreans were clearly aware that each of the three triads of Greek

[1] It is plausible that the use of this position was considered analogous to that made by only partially closing one of the holes of the pipe.

[2] It seems difficult to admit that there could be awareness of the uvula in this type of pronunciation. As a matter of fact this was certainly unknown to Plato and Aristotle.

[3] Belardi 1974, pp. 1-86.

stops was made up of consonants uttered in the three different places of articulation, respectively considered as the anterior, the middle and the posterior, they might have distinguished the consonants of each triad via the degree of obstruction of the oral section of the vocal tract. A confirmation, albeit indirect, of my supposition is hinted in *Scholium in artis Dionysianae*:[1]

[and β is in the middle of π and φ and so forth.] It is not so that any which middle consonant is middle with respect to any which aspirate or any tenuis, rather this very middle, taken singularly, is intermediate between this or that consonant and not between others, for a natural and necessary cause, which now is the time to explain. There are three vocal organs: the tongue, the teeth and the lips. Indeed π is pronounced with the lips tightened and puckered, so that almost no air can flow through; φ instead is pronounced while the lips are somewhat opened and much air flows out; since β is equally pronounced where the lips are puckered, that is, in the same point identified by the same vocal organs aforementioned, surely neither the lips are quite open, as with φ, nor are they quite tightened, as with π, rather there is a medium passage through which air moderately flows out. Thus, necessarily β is between π and φ, and not between other consonants, in that it is pronounced in the same place as the latter, meaning π and φ. Likewise γ is also middle with respect to κ and χ, because it is pronounced in the same place as these, between which it is intermediate: in fact, κ is pronounced with the [dorsum, or mid body of the] tongue which arches against the palate during the emission and hardly allows air to flow out in the first case; in the other, χ is pronounced thanks to the same type of emission with the tongue that does not arch against the dorsum and absolutely does not touch the palate; on the contrary, it allows air to flow out in quantity. The consonant γ is pronounced similarly thanks to the same type of emission with the tongue that neither arches as much against the palate as for κ, nor does it draw away from it as much as for χ, but it leaves a slight passage for air to flow through. Equally so, δ is between θ and τ, and not between other consonants, in that it is pronounced in the very point as these, which I shall tell you: τ is indeed pronounced with the tip of the tongue which moves towards the teeth and hardly lets air pass, which in any case is present, θ is pronounced with the tip of the tongue which moves away from the teeth and lets a great deal of air to flow out; δ is in turn undoubtedly pronounced with the tip of the tongue which neither moves completely towards the teeth, nor moves much away from it, but as could be said, touches and does not touch. For these natural causes not just any middle consonant is middle between any which tenuis and any aspirate.

Whether his name be Melampus or Diomedes, the Byzantine scholiast is not precise in citing the sources unknown to us when dealing with the subject matter. Its content is presented in such a manner that at a first reading seems to be re-conducible to an imprecise moment of the history of the Greek phonological system. The scholiast's account could be dated farther back and result in any case acceptable to those who might have transmitted or recopied it, besides the fact that we today consider these authors as being critical and competent in their rewriting or not. The reasoning behind this is evidently that the *scholium* examines neither the approach stage, that is the preparatory phase where the phonatory organs are arranged in a precise way, nor the hold stage, when the organs maintain a certain position, constraining the air built up, rather the release stage, where the organs move swiftly, releasing the air through a passage. What is particularly interesting and decisive in this context is the affirmation that β concedes the air a passage, διέξοδον, which is intermediate between those

[1] Uhlig 1979², VI (= GG I III 43, 10-44, 14).

left it by π and φ correspondingly, which are the other two consonants having a bilabial point of articulation. Now, this type of notation constitutes a sure proof that the systemization of these phones in the well-known triad of bilabials, dentals and velars, clearly accepted by the *scholium*, is referred to a stage in which all three contoids of each of the three series were surely stops as for their manner of articulation. As a matter of fact, it is difficult to accept that the pronunciation of β and φ as spirants could allow the appreciation of differences in the configuration and the width of the opening of the mouth as it was tightened. It is possible to imagine the reason for the realization of a growing degree of openness of the passage for the air flow by π, β, and φ, articulated respectively as voiceless plosive, voiced plosive and voiceless aspirate. Assuming that in Ancient Greek culture there was a lack of knowledge of the role of vocal folds in phonation, the only explanation can be that the puckering of the lips, actuated during the stage of release for the fortis consonant π and not for the lenis β, might have given, so to speak, the «synaesthetic» impression that because of less tension in the labial muscles during the hold, the second consonant would open a passage of airflow wider than the first. In view of the lack of knowledge that the glottis was open during the actualization of the aspirate stops, then the attention given to the release of φ, also produced in isolation without the co-involvement of the lips in any which successive articulation, would have persuaded that the widest opening of the lips in the aforementioned consonant left a greater passage for the flow of a certain quantity of non-vibrating air, which thus was perceived as an aspiration. Similar considerations can be made for the relationships established within the velar series. Because of the unawareness of the glottis' opening accompanying the production of χ, and not of κ, the *scholium* assigns its role to the passage left for the airflow by the mid body of the tongue, which was arched backwards against the roof of the oral cavity in correspondence to the area of the soft palate. Therefore this opening was perceived as the greatest with respect to that which was felt during the release of κ and accordingly regarded as the least. The airway in the release of γ was noticed as greater than that of κ. Albeit in an undistinguishable manner, in fact, the tension of the muscles implicated was felt less in the former compared to the latter. For the very same reasons, the greatest distance of the tip of the tongue from the upper dental arch during the release was assigned to θ, whereas the least and the intermediate to τ and δ respectively.

The phonetic analyses behind the considerations I have tried to deduce from the examined texts seem rather advanced and are understood within the cultural framework I have reconstructed.

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