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A Companion to Ancient Greek and Roman Music edited by Tosca A. C. Lynch and Eleonora Rocconi

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Without doubt, this book will be very useful to postdoctoral students and researchers needing an overview of ancient Greek and Roman music. Within a rich thematic division, it offers a number of stimulating and accurate details about nearly all aspects of ancient music in a successful interplay of many approaches that will allow readers to gain an inclusive understanding of ancient μουσική.

The book includes 35 chapters distributed in five areas of interest ranging from key musical myths and divinities such as the Muses, Apollo, Dionysos, and Pan [13–57]; the legendary initiators of music and inventors of instruments, Orpheus, Amphion, Zethus, and so on [11–86]; to the most difficult theoretical questions concerning all features of Greek and Roman music [243–363]; and going through topics such as the relationship between Greek musical culture and other Mediterranean musical traditions from the Bronze Age to the Classical Age, aesthetics, cosmology, medicine, politics, and gender studies [379–433]; without forgetting the music cultural heritage and the reception of Greek music theory from the Middle Ages to modernity [449–488]. The book offers many illustrations as well as an appendix devoted to harmonic diagrams.

In their introduction, the editors recall how a wide range of scholarly disciplines has paid attention to ancient music culture over the past decades.

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With the so-called performative turn, classicists adopted the definition of song culture, complementing philological analysis. Ancient philosophy and science have recognized the key role played by harmonics. Papyrological findings have unearthed a host of texts that have renewed the approach to ancient music.[1] Music archaeology has promoted experimental explorations with the aim of re-creating ancient instruments and playing techniques. The recent archaeology of performance aims to reconstruct the conditions of ancient performances to which must be added the study of ancient acoustics, which were so different from ours, starting with the fact that ancient music was listened to outdoors and not in a quiet, closed place. The way in which ancient people perceived, conceived, and produced their sonic world is a new and important field of research. Ethnomusicology and anthropology are also brought to bear in the quest for the nature of musical emotions and gestures, an interdisciplinary endeavor.

It is impossible to give in a few pages a fair account of the richness of those 500 pages.[2] That is why, given the epistemological color of the journal *Aestimatio* and, as Stefan Hagel's revolutionary work constitutes the background of many chapters of this book, I shall concentrate on the chapters dealing with harmonics, acoustics, and organology.

I should nevertheless like to draw attention to some other impressive chapters, such as Armand D'Angour's "Old and New Music: The Ideology of *Mousikē*" [ch. 29, 409–420], which produces a remarkable technical analysis, both stylistic and musical, of so-called New Music. D'Angour starts with Timotheus' famous fragment of the *Persians* and traces the influence of musicians such as Melanippides, Phrynis, and Cinesias while disparaging "theatrocratic" tendencies of elite commentators such as Plato and Aristophanes [410–414]. This is especially because of New Music's democratic standards, as illustrated by the picture of the battle of Salamis in Timotheus' *Persians*, with its military metaphors, which involve an egalitarian ideology.[3]

I should also mention Marco Ercoles' study, "Music in Classical Greek Drama" [chapter 10, 131–144], which is undoubtedly one of the richest of the book and covers all the musical and rhythmical features of tragedy and comedy. The emphasis is put on the actor, his growing prominence reflected by

[1] On this, see Maria Chiara Martinelli, "Documenting Music" [ch. 8, 103–115].

[2] You will find a succinct account of each contribution on pages 3–5 of the volume.

[3] See Eric Csapo and Peter Wilson, "The Politics of Theater Music in Fifth- and Fourth-Century Greece" [ch. 30, 421–433, esp. 424].

the increasing number of solos during the second half of the fifth century BC, his performance claiming a complex virtuosic musical style with asymmetric free-form metrical structures, intricate rhythms, harmonic modulations, and trills. Accurate comments are made about the *aulos*; its suitability to intense emotions, especially because of its capacity to play several modes on the same pair of pipes; and its use by star *auletes* of the New Music [135]. We are reminded of the "grammar" of μουσική when dealing with meters, rhythms, and ἁρμονίαι [136–139], and the rhythmic patterns of the dramatic choral songs are examined with accuracy. As Ercoles maintains that the importance of the *aulos* in plays is the reason one should not talk about the lyric in dramatic songs but should rather employ the word "melic" [135].[4]

In a condensed and virtuosic chapter, "Ancient Greek Music and the Near East" [ch. 17, 229–241], John C. Franklin divulges all the complexity of the relationship between Greek musical culture and other Mediterranean musical traditions, from the Bronze Age to the Classical Age, offering a very detailed account (which is impossible to summarize) of both organological and geographical features (the types of lyres and string instruments relative to countries, the different harmonization techniques, their anthropological value, and so forth). Nevertheless, Franklin's precise and extensive bibliography lacks some important references. For instance, concerning Philoxenus [237], he jumps from West 1992 to Hagel 2010 and Lynch 2018 without mentioning A. Bélis' technical study "Un 'nouveau' dithyrambe. Les *Mysiens* de Philoxène de Cythère" [2005].

At the beginning of chapter 19, titled "Harmonics" [257–274], Andrew Barker makes some useful epistemological remarks about two types of scholarly approaches to the ancient writings on harmonics: the first type represented by Barker himself, focusing on the scientific activity as a mode of intellectual inquiry implying methodological principles and conceptual frameworks; the second type represented by Stefan Hagel, focusing on our evidence about patterns of intervals on which Greek music making was based. Barker has extracted this evidence from all sorts of texts: literary, source, the archaeology of instruments, iconography, ethnomusicology, physics, and so on.

Let us start with Barker's review of the basics of the ancient Greek harmonics. First is the privileged interval of the perfect fourth, the construction of the octave from the two fourths plus a disjunctive interval, which is equal

[4] Claude Calame deserves mention for having paid attention to this long ago [1998].

to a major second and defined as the difference between a perfect fourth and a perfect fifth [288], and the difference between the fixed and moving notes of the tetrachord creating different types of tetrachordal divisions classified into enharmonic, chromatic, and diatonic genera (γένη) and their variants [259]. Barker also recalls the empirical origin of the so-called ἁρμονίαι with their regional names (Phrygian, Ionian, and so on), to which Mark Griffith adds useful information in his "Between Local and Global: Music and Cultural Identity in Ancient Greece" [ch. 27, 381–396]. Barker stresses the privileged role of concords (συμφωνίαι) in the measuring of intervals based on hearing at a time when technical measuring instruments were undiscovered, the tedious and haphazard search for the interval unit, and the smallest interval that the ear can detect.[5]

Barker mentions the arrangements by fifth-century musicians of the intervals in scales and tuning schemes. Testimonies exist of these arrangements, for example, Aristoxenus' record of an early quantification of the intervals between keys (τόνος) based on the location of the finger holes on *auloi*, and Aristides Quintilianus' description of six systems of ἁρμονίαι (also mentioned by Plato), each system, except the Mixolydian, having an enharmonic tetrachord as its core with other, irregular intervals reflecting attempts to capture the substructures of the music that they actually performed [260].

Barker also notes the anomalous character of the Mixolydian scale (quartertone, quartertone, tone, tone, quartertone, quartertone, tritone),which Lamprocles proposed to reduce by giving it the form quartertone, quartertone ditone, quartertone, quartertone, ditone, tone, that is to say, by placing two enharmonic tetrachords plus a disjunctive tone at the top of the scale [261]. Barker also recalls Eratocles' seven, cyclic arrangements of the octave.

He then focuses on Aristoxenus' project to transform harmonics into a science on the model of Aristotle's *Posterior Analytics* [262], from the natural succession of vocal or instrumental intervals as it rises and descends in accordance with the "law of fourths and fifths"; on his quantitative delimitation of the scales with their genera in terms of the whole tone and its fractions (including the extent of the range within which the movable notes can travel from one *genus* (γένος) to another); but at the same time on his rejection of exclusive quantification and his appeal to auditory perception in the identification of the scalar function (δύναμις) whereby a sound qualifies

[5] A quarter tone for Aristoxenus' predecessors, the ἁρμονικοί, who mapped their systems onto a grid divided into quartertones.

as a note within the relevant structure that introduces a melodic function of the note [263–264].

Barker follows the scepticism of contemporary studies on Pythagoras as the inventor of mathematical harmonics, of which he recalls the principles of the representation of intervals as numerical ratios [265]. He considers Philolaus' view of ἁρμονία as the musical principle of cosmology and notes his mathematical interpretation of the symmetries of the octave structure in term of numeric ratios (3:2 + 4:3), delimiting the disjunctive tone as 9:8 and calculating the value of the octave (2:1) as five 9:8 + two διέσεις (256:243) [266]. Barker views Philolaus' ἁρμονία not as a practical attunement of an instrument but as an archetype of universal significance. Indeed, Barker recalls that Philolaus preceded Plato in the notion of a mathematical universal harmony [267].

It is also said that Archytas discovered the relevance of the three mathematical means in musical structures, the impossibility of dividing an epimoric ratio into two equal ratios of integers, and the epimoric or multiple ratio of a concord. Nevertheless, it is Archytas rather than Philolaus that Plato criticized in his *Republic*, when he complained that the Pythagoreans focused only on audible sounds, as shown by reports of Archytas' system of numerical ratio and their correspondence to scales used in musical practice.

The *Sectio canonis* is then described, with Archytas' mathematical background and its famous division of the monochord (κανών), a measuring strip placed under its string and used as a lecturer's audiovisual aid to mark the points at which the instrument produces each note of a diatonic scale spanning two octaves. Barker recalls the well-known fact that Plato gave his "World Soul" the structure of a diatonic scale spanning four octaves and a major sixth, and that the human soul's organization mirrors that of the universe so that human access to the cosmic ἁρμονία is possible [268]. The chapter also recalls the traditions that have flourished from the *Timaeus*.

To what he calls "a repetitious and rather simplistic musical analysis with massive metaphysical ambitions" [270], Barker opposes the current of thought stemming from Archytas' work, for which the astronomer and mathematician Ptolemy is our only source. On the basis of epimoric ratios corresponding to the extent to which the bounding notes of an interval are blended and unified, Ptolemy classifies the intervals in order of excellence—homophones, concords, melodic intervals [270]—and he requires the systems to face tests before being accepted, using the monochord and other instruments, such as the helicon [271].

The chapter ends with consideration of the relations between empirical and theoretical harmonics [272].

This contribution, which perfectly reports the issues of ancient Greek harmonics, devotes only a few lines to the disjunct octave, perhaps because Barker is less interested in unusual and maybe archaizing varieties of the octave such as the conjunct octave (tone, tone, semitone, tone, tone, semitone, tone), which could constitute an alternative to the diatonic disjunct octave of Plato's World Soul. When Barker moves on to the question of the heptachord, "Apollo's lyre", readers might find Chrestos Terzes' contribution, "Musical Instruments of Greek and Roman Antiquity" [ch. 16, 213–227] and Wersinger 2008, 289–295 useful.

I would suggest also that Barker's relative silence about octave systems (εἴδη) finds compensation in Hagel's contribution. Indeed Stefan Hagel's contribution, entitled "Notation" [ch. 21, 297–310], does not deal only with musical and rhythmic notation. Hagel's innovative thesis is that notation was the conceptual tool of Greek musical theorists. This means that musical notation went hand in hand with the need for modulation and for relating different modes to each other [298]. Here some further information is needed, as one has to know that three registers of pitch were distinguished from high to low: the tetrachord of the *Hyperboleas* (high), that of the *Meses* (medium), and that of the *Hypates* (low). This resulted in two systems, the 15-note disjunct and the 11-note conjunct. Such a systematization increased the sonic possibilities. There is obviously the possibility offered by the genera of diversifying the notes, as Barker has recalled, that the system be capable of interpretation in the enharmonic, chromatic, and diatonic genres. But even greater freedom is secured by the possibility of passing from notes of the conjunct system to those of the disjunct system. Finally, there is the possibility of a number of "tropes" (τρόποι): each *mese* (μέση) allows one to interpret the whole of the great system, which thus introduces a great number of new musical forms. Hagel's contribution is important for bringing all this to light.

Hagel offers a diagram that maps both the vocal and the instrumental notation of the keys (τόνοι) [299]. Keys regulate the pitch distances, allowing modulation between one key to another, a technical device that dates back to the Bronze Age in the Mesopotamian lore, when seven keys were related to a seven diatonic key tuning. All this was known long before Eratocles enumerated them as "species (εἴδη) of the octave" in his heptatonic system, which in turn soon gave way to Aristoxenus' 13 keys, which was more suited to modulation, and to the 15 keys detailed by Aristides Quintilianus.

Although strikingly economical, Hagel's diagram [299] is difficult to use. You get more information from the diagram offered in his *Ancient Greek Music* [Hagel 2010, 13], starting with its better printed characters, clearer marking of the fixed notes, and the *mese* of each key.

On the left of the diagram on page 299 [see Plate 1, p. 174 below], you find a set of 24 notes of a scale, including three octaves and two notes from re to si, with side-by-side corresponding notation (both instrumental and vocal) forming a grid of semitones (e.g., I K/O = Fa♯ = the Iastian *mese*). On the right, you find the oldest system of notation (instrumental and vocal) based on triplets corresponding to *pykna* (πύκνα) (i.e., three close pitches corresponding to enharmonic, chromatic, and diatonic genera, e.g., K, ⋉ + ¼, Ϡ + ¼ = fa♯, sol♭, sol). Hagel points out that the triplet-based πύκνα-system was progressively abandoned when some additional modulating keys were added from the Mixolydian to the six ancient keys (Lydian, Hypolydian, Phrygian, Hypophrygian, Dorian, Hypodorian) with their genera [300].

At the bottom of the diagram, you find a list of 11 *mese* of the keys that regulate the pitch distances between instantiations of the scale. On both the top and bottom of the diagram, the two cyclic arrangements of keys that I have already mentioned are represented: the 15-key system (the highest replicating the lowest, Hyperdorian) and Aristoxenus' 13-key system with their proper names (the highest replicating the lowest, Low Mixolydian).

Suppose you want to modulate from Iastian to Phrygian (or in Aristoxenus' keys, from Low Phrygian to Phrygian). Each key is located in a diagram corresponding to its key: Iastian is K, Fa♯ and Phrygian is M, sol (we shall soon understand why). This means that you have to make each note of each key correspond to its intervallic shape according to the referential system, adding sharps or flats when necessary:

Iastian

Fa♯ 1 Mi 1 Re 1 Do♯ ½ Si 1 La ½ Sol♯ 1 Fa♯, or
K ^ Z N C < 7 K (vocal: O Θ U Γ Z I M O)

Phrygian
Sol 1 Fa 1 Mi♭ ½ Re 1 Do 1 Si♭ ½ La 1 Sol.

Notice that both scales obey the same pattern: T T S T T S T (two tetrachords plus one disjunct tone). Hagel does not explain why, and the reader might get lost. In fact, each key must show the same pattern, starting (for reasons that I explain further on) with the:

Lydian (*mese* La) la sol fa mi ré do si la.

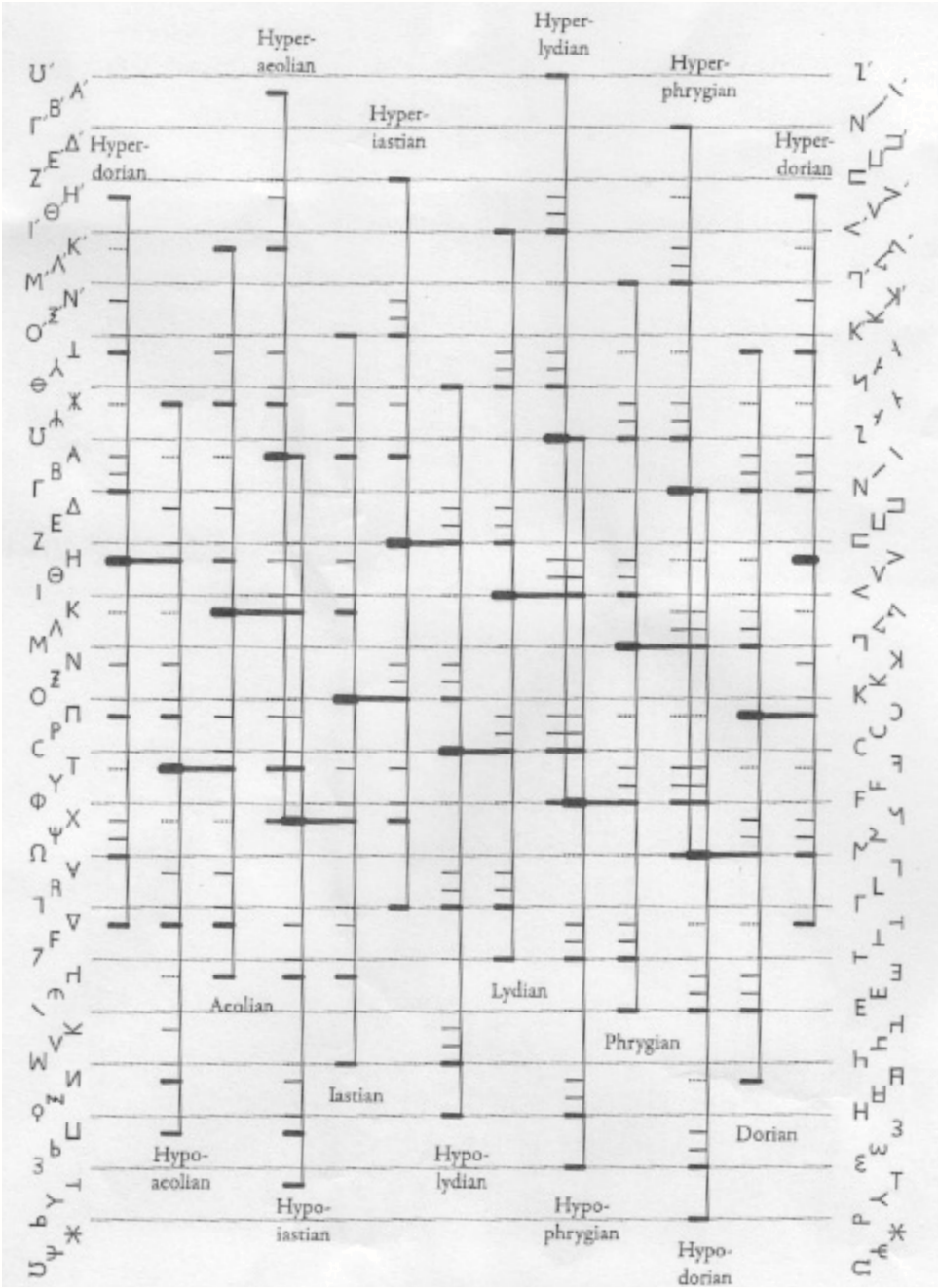

Plate 1. The fully developed system of notation by S. Hagel

Lynch and Rocconi 2020, 199. © 2020 John Wiley & Sons, Inc.

Hypolydian (*mese* Mi) mi ré do si la sol fa♯ mi

Dorian (*mese* Fa) fa mi♭ ré♭ do si♭ la♭ sol fa

Hypodorian (*mese* Do) do si♭ la♭ sol fa mi♭ ré do

Iastian (*mese* Fa♯) fa♯ mi ré do♯ si la sol♯ fa

High Mixolydian (*mese* Si) si la sol fa♯ mi ré do♯ si

Low Mixolydian (*mese* Si♭) si♭ la♭ sol♭ fa mi♭ ré♭ do si♭

Phrygian (*mese* Sol) sol fa mi♭ ré do si♭ la sol

and so on.

Things get more complicated because those scales are shaped according to their *mese*. But they help building the so-called diatonic *species* of the octave, starting with Do [see 492, C]:

Low Mixolydian do ré♭ mi♭ fa sol♭ la♭ si♭ do STTSTTT

Lydian do ré mi fa sol la si do TTSTTTS

Phrygian do ré mi♭ fa sol la si♭ do TSTTTST

Dorian do ré♭ mi♭ fa sol la♭ si♭ do STTTSTT

Hypolydian do ré mi fa♯ sol la si do TTTSTTS

Hypophrygian do ré mi fa sol la si♭ do TTSTTST

Hypodorian do ré mi♭ fa sol la♭ si♭do TSTTSTT.

Also notice that instead of mapping the keys according to their range in the scale system, there is the following:

1	2	3	4	5	6	7	8	9	10	11	12
Do	Do♯	Ré	Ré♯	Mi	Fa	Fa♯	Sol	Sol♯	La	Si	Si♭

Hagel's diagram maps the triplets' notation signs of the musical scales (e.g., Hypolydian Lydian Hyperlydian) so that the sharp and flat keys are set according to their order of magnitude from either side of the only key without accidentals. The Lydian is, then,

Ré♯	Sol♯	Do♯	Fa♯	Si	Mi	La	Ré	Sol	Do	Fa	Si♭
4	9	2	7	11	5	10	3	8	1	6	12

But why must we privilege the Lydian? That is Hagel's second innovative thesis. Hagel calculated that, given an average height of an ancient Greek male player of 168 centimeters, the length of a lyre string could be estimated at 43.5 cm so that the Lydian *mese* could be assigned the value of 490 hertz, the Greek absolute pitch (our contemporary standard being La = 440 Hz). That is why Hagel discusses what musicologists call the "Bellermann Convention" [303–304]. Instead of choosing as the ancient core scale the Lydian that stands between the Hypolydian and the Hypophrygian *tonoi*,

Bellermann chose the Hypolydian C (= 370 Hz), making the pitch of the transcriptions appear a minor third too high. Hagel shows that it was the Lydian, as unequivocally testified by sources, that constituted the origin of the instrumental notation. He highlights the reasons why scholars mistakenly considered the Hypolydian to be the reference key (according to the relationship between *tropes* and musical notation, the so-called tables of Alypius' *Musical Introduction*).

The mistake, according to Hagel [303], is due to the fact that by modulating to Hypolydian (mi) and Hypophrygian (re), the pitches required were established within one octave that corresponded with the pitches of the diatonic Hypolydian. Scholars have erroneously assumed that the list of signs corresponding to that octave was a way of notating the Hypolydian. But this is wrong. For instance, Hypolydian notates fa♯ by the vocal sign "O", and the Sol a semitone above it by "Ξ", the second sign in the same triplet (in instrumental notation, these are "K" and "⋉"). However, "Ξ" denotes the same pitch as "M", which is a basic sign used in Lydian. Therefore, the list of basic signs, by including "M", includes the respective Hypolydian pitch, albeit with the "wrong" sign. The list of basic signs includes "M", which corresponds to a diatonic Hypolydian pitch, but this does not mean that that list constitutes the diatonic Hypolydian scale.

Hagel also comments on the rhythmic notation [306]. On rhythmics itself, see ch. 20, 275–295, where Tosca Lynch connects the key components of rhythmic pulse (upbeat, *arsis* and downbeat, *thesis*), thus entailing a melodic alternation of higher and lower pitches of the voice to their correspondent feelings of excitation or relaxation [277] and with the prosody of the Greek language. She also highlights the principles of Aristoxenus' study on rhythms [281], giving as an illustration of *rhythmopoiia* the *Seikilos Epitaph* [287–289].

Hagel's chapter ends with a useful illustration of those principles in a case study: an aria from a songbook from the second century AD [307]. The key is the Iastian (as shown by the three sharps) with a modulation between diatonic C and chromatic T.

Egert Pöhlmann's contribution, "Acoustics" [ch. 18, 245–256], starts by evoking Galileo, whom he supposes to have used experimentation in the study of free-falling motion; Mersenne, who determined the speed of propagation of sound; and Gassendi, who discovered the uniformity of the speed of propagation of sounds, definitively invalidating the ancient theory of difference of pitches according to speeds of propagation of the sounds.

It is said that the "kinetic" conception held by certain ancient physiologists such as Alcmeon of Croton or Empedocles, according to which the sound results from an impact (πλῆξις), setting the air in motion, was improved by Anaxagoras, thanks to his concept of hypostrophy (i.e., the propagation toward the ears of the impact of the breath on the substance of the air results from its periodic return, like an echo, in the manner of the vibrations of the string of the lyre, the continuity of the sound being an illusion due to the weakness of the sense of hearing). Archelaus would be the first to define sound as resulting from the movement of impact through still air [246].

We then move on to the Stoic "wave" theory. Chrysippus believed that after a continuous impact of air by the breath (πνεῦμα), sound results from its spherical vibration up to the ears. Next, the corpuscular theory of the Atomists is recounted: sound results from corpuscles of compressed air set in motion, which penetrate the ear cavities. Then, we turn to Archytas, who explains the propagation of sounds to the ear by the collusion of moving bodies, whose speed varies with the pitch of the sounds, a theory taken up in part by Plato, who defines new sound characteristics by no longer bringing into play exclusively the speed of sound, but the nature of the percussive motion.

Aristotle admits that sound results from the impact of moving bodies in the medium of still air, which takes the form of the object like a print (σχηματισμός) and carries it to the ear—sometimes not without distortions (μετασχματίζεσθαι), as shown by the propagation of language [249]. He adds to Archytas' theory the claims that high-pitched sounds are like sharp objects and low-pitched sounds are like heavy objects, so that rapidity and slowness are effects of the shape of sounds. Aristotle is unable to account for the consonances, which suppose the simultaneous hearing of sounds of different heights and, therefore, of distinct speeds; the solution offered by his theory of mixture does not take account of the dissonances, since they are not a mixture of sounds and yet are seized simultaneously [249–250].

In Porphyry's summary, Heraclides of Pontus held that sound propagates by vibration and that the time in which it does this is imperceptible, thus coming closer to modern theories of frequency. The *Sectio canonis* takes up the same theory by explaining the difference in the pitch of sounds no longer by their speed but by the compactness and number of the motions impacting the ears, and develops this theory in a mathematical account that draws on epimoric ratios ($(n + 1):n$, e.g., 3:2) and multiple ratios ($mn:n$, e.g., 2:1) to explain consonances and dissonances [251].

Pöhlmann's contribution ends with the survey of the Peripatetic Strato's *De audibilibus*, which seems to take up, not without incongruity, Heraclides theory of the imperceptibility of sound vibrations while partly rejecting the Aristotelian theory of impressions of the air (σχηματίζεσθαι) in reducing it to the question of the difference in the timbres of the sounds.

This well-informed contribution contains relevant observations on some aspects of the epistemology of ancient acoustics (e.g., the recourse to analogy [245, 247], even if the Empedoclean assimilation of the ear to a bell is controverted, as it might be an *aulos*). But one must always keep in mind that the main acoustical problem that Pöhlmann deals with is the question of the pitch of the sounds at the origin of consonances and dissonances. If they fail to pay attention to this, readers might be surprised by the fact that the "kinetic" conception held by ancient physiologists [246] is presented in a way that gives the impression of being close to the pneumatic-continuist conception of the Stoics [247] and opposed to the corpuscular conception ascribed to the Atomists, so that Empedocles is cut off from the Pythagoreans, who share the corpuscular conception [see 249]. (That Empedocles held an acoustic corpuscular theory is not in doubt: it suffices to remember that, for him, any sensation involves effluvia and, therefore, corpuscles).

One must keep in mind that the most widespread theory among ancient physiologists was the percussive theory of acoustics, which posited the collision of a projectile against an obstacle, whether it was another body or air. This entailed that air be made up of particles, so the same principle applied to projectile theory (ballistics) and acoustics. It is this very theory that is shared by Archytas, Plato [*Tim*. 67b2], and Aristotle, who likens this phenomenon to the impact of balls bouncing on smooth surfaces [*De an*. 2.8.419b21–23].

With the Stoics, the ballistic model ends and is supplanted by a continuous pneumatic model, designed from a pulsating interpretation of air as the tension of opposing forces. Nothing is said by Pöhlmann, either, about the fact that corpuscular acoustics tried to explain the movement of sound by resorting to the notion of circular thrust [Plato, *Tim*. 79b–c2]. Plutarch later calls this ἀντιπερίστασις, a theory explaining the movement of sound as that of an arrow pushed forward by the pressure of air [[Aristotle], *Prob*. 11.6.899a34–b3]. This theory is encountered, with some modifications, under the name of "transmission" (κατὰ διάδοσιν) in Alexander of Aphrodisias' work, who attributes it to Aristotle. But there is a difference: whereas in the Platonic model air moves, in the transmission theory, air is continuous and indivisible. It shapes (σχμάτιζει) the neighboring air and so on, until it

returns circularly to the starting point, allowing the sound to be transmitted [Alexander of Aphrodisias, *In de anima*, 48.12–21; see also [Aristotle], *Prob.* 11.23.901b16–23].

One must not omit to read Sylvain Perrot's "Ancient Musical Performance in Context: Places, Settings and Occasions" [ch. 7, 89–102], in which the architecture of musical performances is thoroughly examined, noting especially the acoustical properties of the theater, such as the reverberation of sounds, as illustrated by the sanctuary of Asclepius in Epidaurus, where numerous limestone seats filter out low-frequency sounds such as the murmur of the crowd, while amplifying high-frequency sounds coming from the stage [95]. A few words are devoted to Roman times, when the acoustics of the theaters changed as the σκήνη became a wall closing off the theater, while, according to Vitruvius, tuned bronze vases were set in niches to amplify or modify the sounds. Pages 97–99 are devoted to Apollo's Sanctuary in Delphi and the evolution of musical contests from 586 to early Hellenistic times.

In chapter 16, "Musical Instruments of Greek and Roman Antiquity" [213–227], Chrestos Terzes deals with ancient organology and archaeomusicology. His classification of instruments is rather opaque and difficult for a nonspecialist to follow; for instance, what are precisely the πῆκτις, the μάγαδις, the σαμβύκη, and the τρίγωνον? (Fortunately, some pages later, John Franklin will inform us that the τρίγωνον was a triangle harp [234] and that the σαμβύκη was a high-register bow harp [237]). According to the usual classification, it seems that these are types of harps, but according to some archaeomusicologists, the πῆκτις was actually a sort of lute. But what is its difference, then, from the πάνδουρος, which is also defined as a lute-like instrument?

After brief remarks on the evolution of the playing techniques with new strings [218], Terzes examines instruments [219] starting with the *aulos*,which consisted of two pipes sounding simultaneously as the player blows into reeds, which vibrate and transmit their vibration to the columns of air inside the tubes. The expressive nuances of its sounds varied from a sense of buzzing in low range to a harsh piercing sound like screeching in high register. The range of pitch achieved on the *auloi* has been classified by Aristoxenus into girl- and boy-types, grown-up, *kithara*-playing types, and so on. A list of the finds of *auloi* is given on page 220.

Terzes then describes pipes, the βόμβυξ being the main pipe with finger holes. Initially, pipes were paired and tuned at the same scale, one at a lower pitch (held in the left hand, as shown by the *auloi* of Posidonia and Pydna)

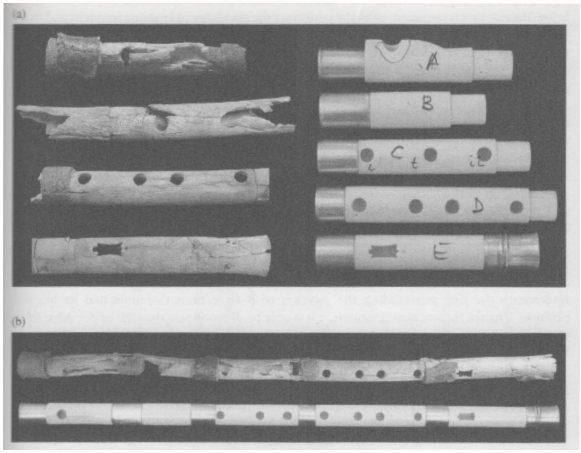

Plate 2. The *plagiaulos* of Koilē

Left: The mouthpiece, the extension (B) attached to the C section, followed by the D and E sections of the find. Right: All five sections as reconstructed by S. Psaroudakes on artificial ivory, in the course of the Hermes Project-NKUA 2016 18. (b) The *plagiaulos* of Koilē. Lynch and Rocconi 2020, 222. Photo by S. Psaroudakes. © 2020 John Wiley & Sons, Inc.

and one at a higher pitch, thus offering a wide range of pitches to the player. Early *auloi* had six finger holes, the lower one being uncovered and the lowest pitch of each pipe. Finger holes served the player to control and modify the airflow through them when small intervals such as quartertones were produced. A tiny transversal lateral hole belonging to the left pipe and called the σῦριγξ could raise the pitch of the *aulos* above its usual register, and when uncovered projected overtones echoing the third harmonic series (i.e., the 12th note from the tonic, a fifth beyond the octave).[6] After the close of the fifth century BC, *auloi* were designed to play more than one scale, thanks to devices such as rotative metal rings keeping irrelevant holes closed. Under the pressure of the New Music and the need to modulate and change scale during the performance, oblong metal rods made it possible to slide a curved rectangular plate up and down along the surface of the pipe and cover or uncover the hole out of hand.

[6] In the lexica, a βόμβυξ, is usually connected with the *aulos*, and a συρίγξ is typically presented as a type of flute attributed to Pan and made up of several pipes joined together.

The chapter ends with a precise (but not easy to follow) study of the πλαγίαυλος of Koilē, a transverse flute of the first quarter of the second century BC, reconstructed on artificial ivory in the course of the Hermes project[7] in 2016 [see Plate 2, p. 180 above]. Terzes discusses Psaroudakes' acoustic reconstruction of the pitches of the πλαγίαυλος [224], but he uses the ASPN (American Standard Pitch Notation) system,

A	B	C	D	E	F	G
La	si	do	ré	mi	fa	sol,

where the letters are the same as those of the sections of the pipe. This makes things difficult to read, especially for a nonspecialist who happens not to be a native English speaker.

To make things easier, I will distinguish between the two types of notation. Terzes hypothesizes that Psaroudakes was wrong when he assumed, according to his own replica,[8] that the scale of the Koile flute included two diatonic conjunct tetrachords with the addition of a tone below:

sol ^{t} la ^{t} si ^{s} do ^{s} do♯ ^{s} re ^{t} mi ^{s} fa ^{s} fa♯ ^{s} sol ^{t} [la.

Knowing that the flute has five sections,

(A) the mouthpiece with the mouth hole
(B) a piece of simple tubing
(C) a first section with four holes, one underneath
(D) second section with five holes, one underneath
(E) lowest section forming a gentle bell,

Psaroudakes made his scale correspond to the holes of the flute as follows:[9]

[7] The Hermes project focuses on the reconstruction of the ancient Greek musical sound, specifically, the reconstruction of fully functional models of 15 ancient Hellenic musical instruments, by drawing on available archaeological evidence, musical iconography, and Hellenic literature.

[8] As measured against a piano, tuned at central La = 442 Hz, the scale of Psaroudakes' replica was the following: sol ^{t} la ^{t} si ^{s} do ^{s} do♯ ^{s} re ^{t} mi ^{s} fa ^{s} fa♯ ^{t} sol (♯). That is to say, a diatonic tetrachord sol-do (2 + 1/2 tones = a fourth) and a diatonic pentachord do♯-sol♯ (3 + 1/2 tones = a fifth). For Psaroudakes there would, therefore, be a disjunctive semitone, do-do♯, but this disjunct semitone seems "unusual" and should be excluded.

[9] "t_h" and "t_l" symbolize the thumbhole for each hand, "h" meaning high corresponding to the left hand and "l" meaning low corresponding to the right hand.

sol ^{t}	la ^{t}	si ^{s}	do ^{s}	do♯ ^{s}	re ^{t}	mi ^{s}	fa ^{s}	fa♯ ^{s}	sol ^{t}	[la
vent	IV_l	$^{III}{}_l$	II_l		I_l	III_h	II_h		I_h	
					T_l				T_h	

According to Psaroudakes, the flute was designed to play in both the diatonic and the chromatic melodic genera [535]. But Terzes does not agree and gives four reasons:

(1) the "La" of the upper tetrachord is hypothetical;
(2) the *lichanos*, the highest movable note of the tetrachord, "sol", is produced on the replica by partially uncovering the hole I;
(3) the "waste" of three finger hole positions (sol, la, sol); and
(4) the disregard of techniques such as overblowing, which lowers the pitches of the tones, and cross-fingering, which makes the resonance twice or more the fundamental frequency.

That is why the flute instead includes two diatonic disjunct tetrachords with a tone between: la-re-mi-sol-la ($D_{iv} - D_i = t - s - (s - s) + (C_{iii} - C_i = t - s - t) + (E - D_{iv} = t)$). Further research involving the making of a wooden replica of the instrument moved Terzes to highlight the fact that the instrument was a fully modulating instrument producing notes spanning an octave. By overblowing, the flute's *ambitus* reached the extent of two octaves and a sixth. Plate 3 illustrates the extent of scale in hertz. The bibliography, essentially focused on Hagel's and Barker's works, omits some relevant studies on the subject [e.g., Melazzo 2014].

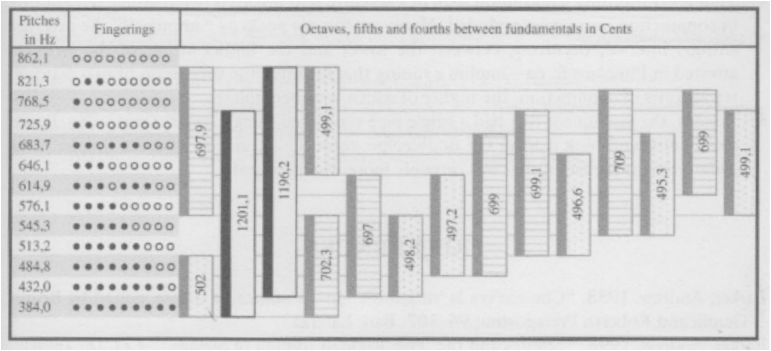

Plate 3. Fingerings, measured pitches, and consonances on the replica of the Koilē *plagiaulos* (Relative A4= 432 Hz)

Lynch and Rocconi 2020, 223. © 2020 John Wiley & Sons, Inc.

In the appendix to "Diagrams of the Ancient Modes (*Harmoniai*), as *Aulos* and Lyra Tunings" [489–495], Tosca Lynch presents transcriptions and diagrams featuring the latest scholarly reconstruction of the ancient Greek modes found in Aristides Quintilian's and Ptolemy's treatises. The aim is to facilitate access to the results of the most recent scholarship for a variety of readers, such as musicologists, composers, professional musicians, and scholars [489]. But it is not intended for those who are not already well informed about the problems of ancient music. A simple example will suffice [492, C]:

The author gives the Mixolydian in this form:

do ré mi fa fa♯ la♭ si♭ do

that is, STTSTTT. But that cannot be: the sequence is in fact TTSSTTT.
The Low Mixolydian scale is

Do ré♭ mi♭ fa sol♭ la♭ si♭ do,

or, if we accept the equivalence Sol♭ and fa♯,

Do ré♭ mi♭ fa fa♯ a♭ si♭ do,

that is, the sequence STTSTTT.
Without additional information, we must, therefore, suppose that there is a typo involving "ré" and "mi"!

One would also appreciate more information about the diagram of the three keys [489 A].

Lynch explains that in Stefan Hagel's monograph of 2010, the "ancient scales" preserved in Aristides Quintilianus' *De musica* record precisely the arrangement of different modes on modulating *auloi*:

> If we set each scale to the pitch of its respective quotationintermediate note mesē—the note that was the key reference point for ancient scales, just as the tonic is for us—it becomes apparent that these scales belong to one and the same modulating instrument, as their top notes fall on the same pitch and the rest can be accounted for fairly easily in terms of instrumental design. [Hagel 2010, 34–38 and 390–395]

This means that each tone stands one tone above the other: La (Lydian *mese*), sol (Phrygian *mese*), and fa (Dorian *mese*). But then, you must take another step that is not explained, that is, you must restore the corresponding scales.

Lydian	do re mi fa sol la si do
Phrygian	do re mi♭ fa sol la si♭ do
Dorian	do ré♭ mi♭ fa sol la♭ si♭ do.

On the evolution of the relationship between music and therapy, one should read Antonietta Provenza's chapter, "Music and Medicine" [ch. 25, 351–363].

She retraces the first use of music in medicine in Homer and presents Plato's conception of the psychagogical power of music based on the *mimesis* of ἦθος (character) by means of harmonies and rhythms capable of producing moderation and avoiding resorting to medicine. Aristotle is also studied and the power of music to produce catharsis by means of certain enthusiastic melodies comparable to the purgatives of medicine.[10] Provenza examines the Neoplatonic writings on the Pythagoreans, mentioning their therapeutic musical disciplines, and especially Porphyry, who endeavors to distinguish the psychagogical effects of music from the mystical and magical effects, thus helping to form the notion of scientific and secularized Pythagoreanism. Other examples are given to illustrate the "pharmacological" effect of music, including Empedocles [356–357]. The question of the paradigmatic relationship between music and medicine is discussed [357], namely, whether music served as a model for medicine.[11]

A rather superficial survey is given of the theory concerning the analogy of rhythm and the pulse according to Galen, Herophilus, Avicenna, and the famous passage of Aristides Quintilian, [*De mus.* 2.17.52 ἐς τὴν τῶν νεύρων ἰδέαν τρέπει], in which Provenza seems to ignore Rufus of Ephesus' work, *Synopsis de pulsibus*, and the question of the possibility of a sphygmology based on *tonoi* is not even asked. The bibliography concerning the pulse misses Leofranc Holford-Strevens' "The Harmonious Pulse" [1993] and N. G. Siraisi's "The Music of Pulse in the Writings of Italian Academic Physicians (Fourteenth and Fifteenth Centuries)" [2012].

My survey shows the richness of the contributions to this volume but also their problems. Undoubtedly a "companion" should not go so far into a topic as to account for the widest range of the latest research. Nevertheless, for anyone who is not satisfied with mere facts but wishes to understand their reasons, further explanation is often needed. Last but not least, the book reflects contemporary research, mostly in English and Italian (there is only *one* contribution in French), which means that important and original scholarship in other languages is overlooked and sometimes not even mentioned in the bibliographies.

[10] On catharsis, see also Francesco Pelosi's remarks in his "Music and Emotions" [ch. 24, 337–349, esp. 342–343].

[11] See Barker's remarks [272 n11] about Philolaus' being the source of the Hippocratic treatise *On Regimen*, in which the development of the fetus comprises *symphoniai*.

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