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ON THE
INTERPRETATION
OF
GREEK MUSIC

By CECIL TORR, M.A.



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ὡς ἀρχαιολογήσων ὑμῶν καὶ καταρίψων ἀπὸ γλώττης ἅπαντας

LUCIAN

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Oxford

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A YOUTH, PLAYING AN EIGHT-STRINGED LYRE, WITH THE PLECTRUM IN HIS
RIGHT HAND AND HIS LEFT HAND ON THE STRINGS.
From a Greek vase in the Author's collection.

ON THE INTERPRETATION OF GREEK MUSIC.

I.

THE ancient notation was arranged for one-and-twenty notes within the octave, each of the seven original notes being followed by two supplementary notes. And as the compass was three octaves and a third, there were seventy notes in all.

Two letters were assigned to every note, one set of letters being prescribed for instruments and another set for voices.

This is the lettering for voices, taking the notes in order of ascent :—

Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ
 Ω Ψ Χ Φ Υ Τ Σ Ρ Π Ο Ξ Ν Μ Λ Κ Ι Θ Η Ζ Ε Δ Γ Β Α
 Ϯ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ
 Ο' Ξ' Ν' Μ' Λ' Κ' Ι' Θ' Η' Ζ' Ε' Δ' Γ' Β' Α'
 Ϯ'

And this is the lettering for instruments :—

Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ
 Ν Ζ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ / \
 Ζ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ
 Κ' ϫ' Ϭ' ϭ' Ϯ' ϯ' ϰ' ϱ' ϲ' ϳ' ϴ' ϵ' ϶' Ϸ' ϸ' Ϲ'
 Ζ'

Thus, in the lettering for voices, the common letters of the alphabet are taken in their natural order from Α to Ω. Next beyond the common Ω comes Ϯ, a modified Α, beginning the alphabet again with every letter modified. And next before the common Α comes Ϯ', a modified Ω, finishing the alphabet with another set of modifications. But here the alphabet omits the letters σ, ρ, π, and passes on from ϫ to Ο', Ξ', Ν', &c., for the sixteen highest notes. This departure from the natural order must be connected with the fact that in the lettering for instruments, as well as here, the letters for these sixteen notes are distinguished only by an accent from the letters for the notes an octave lower down. And this all looks as though the sixteen highest notes were added at some later time.

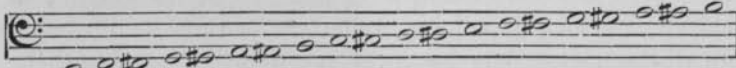
In the lettering for instruments the modifications are introduced in groups of three, the object being to associate each pair of supplementary notes with the original note to which they properly belonged. No doubt, Alypius¹ is mistaken in

¹ Alypius, eisagoge, describes the letters *passim* in setting out the scales. Thus, he speaks of ϫ, Ϭ, ϭ, Ϯ, ϯ as *ἡμίαιφα*, either *ἀριστερόν* or *δεξιόν* and *κάτω νεῦον* or *ἄνω νεῦον*: of ϫ as *ἦτα ἀμελητικὸν καθειλικυμένον*: of ϯ and ϫ as *ὀξεῖα* and *βαρεῖα*: of ϯ, Ϭ and ϭ as *πῖ καθειλικυμένον*, *ἡμίδελτα καθειλικυμένον* and *ἡμίδελτα πλάγιον*: also of Ϯ, ϡ, Ϣ as *ἡμίμυ*, *ἀριστερόν* or *δεξιόν* or *ὕπτιον*.

deriving Η and Π from Π instead of Η, and also in deriving Π from Π, as this would naturally be ∇, a modification of Δ that matches the adjacent < and Δ. And clearly / and \ are modifications of Η and Ν, not accents, as he says. But apparently / and \ must be derived from Α, and √ and √ from √, though the first pair is attached to Ζ, and the second pair to Η, which appears to be derived from Η. And these anomalies make one suspect that the notes originally ended here at Ζ, an octave under Ζ'. The lettering, moreover, is anomalous in the lowest notes as well, ending there with Τ, √, √, √, <, √, just as the lettering for voices ends with √, √, √, √, √. And that looks as though the notes originally stopped at ξ, two octaves under Ζ. But this ξ and the Γ and C above coincide with the √ and Γ and C in the lettering for voices. So these three letters and the six below may be survivals from a time when both the letterings were alphabetical. But this is all a barren ground for speculation, as nothing can be proved.

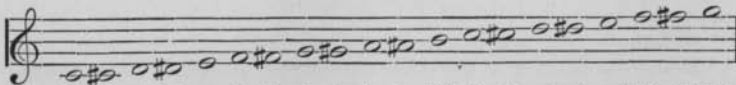
The letterings have been transcribed as follows in all the best-known versions of the music found at Delphi and elsewhere within the last few years:—

D	A	γ	β	φ		W	-	∞	7	F	Γ	Ω	ψ	φ	Υ	C	P	O	
√	*	T	U	H	V	∞	H	∇	P	V	X	T	Π						



C	∇	∞	ξ	∞	H	H	H	E	E	T	T	Γ	M	∞	F	E	C	O	K
∞	*	T	β	H	F	H	E	T	L	E	M	T	O						

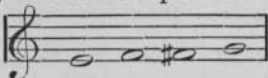
M	Λ	I	Θ	Z	Γ	B	U	∞	φ	J	O	M	Λ	I	Θ	Z	Γ	B	U
E	N	K	H	E	Δ	A	*	I	E	N	K	H	E	Δ	A				



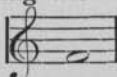
Γ	<	<	V	C	N	/	Z	T	H	T	K	T	<	<	V	C	N	/	Z
∞	K	Δ	>	U	C	\	A	T	∞	K	Δ	>	U	C	\				

This system of transcription produces only forty notes in place of seventy, so that thirty of the modern notes are used for two Greek notes apiece. And this gives rise to three objections.

In the first place, the transcript is ambiguous. Thus, for

example, the group  may stand for any

one of sixteen different things, □ □ □ Z, > N / \, &c. And this ambiguity does actually lead to blundering. Quite recently, in dealing with a piece of ancient music, an excellent

critic took an  in the transcript to mean an N in the

original, and proceeded to argue that the piece was written in a certain key; when in reality the original had □, a note belonging to another scale¹.

Secondly, in making one modern note do duty for two ancient notes, the transcript is giving the same pitch to notes that were of different pitch.

In a degenerate form of ancient music there were indeed such things as *homotones*, or notes of equal pitch. Thus, in setting out a scale of semitones, Gaudentius² puts ♯, ♮, ♭, ♮, ♭, ♮, ♯ in the scale with ♯, ♮, ♯ as *δμότονα*, while Aristeides³ puts ♯, ♮, ♭, ♮, ♯, ♮ in the scale with ♮, ♭, ♮ as *συμφωνίαι*. But the origin of these *homotones* is plain. The old notation had provided for a pair of supplementary notes after each of the original notes, putting ♮ (*v*) and ♯ (*τ*) between ♯ (*φ*) and ♮ (*s*), ♮ (*ρ*) and ♮ (*π*) between ♮ (*s*) and ♮ (*ο*), and so forth. But when the scale was limited to semitones, there was only one supplementary note between *φ* and *s*, only one between *s* and *ο*, &c.; and as these supplementary notes were placed about half-way between, it did not really matter whether they

¹ See the *Classical Review* for December last, vol. ix. p. 468, and the author's note thereon in the *Athenæum* of December 14.

² Gaudentius, *eisagoge*, 22.

³ Aristeides, *de musica*, i. 11. The reader may be cautioned against the version of this passage in Jahn's edition of Aristeides, p. 17. It is printed there with Bellermann's emendations; and he 'emended' the reading of the MSS. to make it suit a theory of his own.

were known as ν or τ , as ρ or π , &c. Gaudentius, however, has selected the letters that come first, ν after ϕ , ρ after s , ξ after o , &c., while Aristeides has selected the letters that come second, τ , π , ν , &c.

That is exactly what has happened to the sharps and flats in the modern scale of equal temperament. There is only one supplementary note there between F and G, only one between G and A, &c.; and as these supplementary notes are placed half-way between, they are known indifferently as F sharp or G flat, as G sharp or A flat, &c. In some keys, however, the modern musician follows Gaudentius in taking the first term in each pair, and speaks of all the supplementary notes as sharps; whereas in other keys he follows Aristeides, takes the second term, and calls them flats.

But this method of transcribing does not make *homotones* of the notes that actually were such. It attaches \neg (τ) to ζ (s) in place of ν (ν), \sqcup (π) to φ (o) in place of ρ (ρ), and so forth. In fact, it follows the system of the tempered scale in giving the same pitch to F double sharp and G natural, to G double sharp and A natural, &c. And there is not any precedent for that.

The lettering for instruments does indeed suggest the use of sharps and double sharps in place of sharps and flats, as the modified letters are both placed after the original letter in every group. For example, the letters F, μ , ν , C, υ , ρ , K, ω , λ , Γ seem to answer better to G, G sharp, G double sharp, A, A sharp, A double sharp, B, B sharp, B double sharp, C, than to G, G sharp, A flat, A, A sharp, B flat, B, B sharp, C flat, C. And there is no harm in speaking of the supplementary notes as sharps and double sharps. But when the transcript gives the same pitch to ν and C, to ρ and K, to ω and Γ , &c., it is assuming that the same pitch may be given to G double sharp and A, to A double sharp and B, to B sharp and C, &c.—a thing that is impossible without the tempered scale.

And that provokes the third objection to this system of transcription, to wit, that it involves the modern scale of equal temperament.

There are some passages in Aristoxenos which look as though he was acquainted with a tempered scale; but when these passages are taken with their context, that notion is dispelled.

He defines a Fourth as the smallest of the intervals that make a concord, and a Fifth as the next smallest of those intervals; so that his Fourth is clearly a true Fourth, and his Fifth a true Fifth. Having made these definitions, he states that a Tone is the amount by which a Fifth exceeds a Fourth, and elsewhere he defines a Tone as the difference between the two smallest of those intervals that make a concord; so that his Tone can only be a major Tone¹. And thus, when he proceeds to say that a Fourth contains two Tones and a half, he must be using 'a half' quite roughly, to indicate a quantity that was not really more than '442475.

Several of the ancient writers call attention to the fact that what was termed a Semi-Tone was not exactly half a Tone. And they explained the fact by saying that the term was not to be compared with terms like Semi-Cubit, which meant a measurement of half a Cubit, but only with such terms as Semi-Vowel, which meant a letter not unlike a Vowel². No doubt this explanation may be incorrect; but the fact itself is incontestable.

In face of those definitions of a Tone and Fourth, it is absurd to argue that Aristoxenos must be speaking of a mean Tone and a tempered Fourth, when he says that a Fourth contains two Tones and a half, or when he uses language to

¹ Aristoxenos, p. 45, ed. Meibom, *ἔστω δὴ τῶν συμφώνων ὑπερὸν μεγέθη. ἐλάχιστον μὲν, τὸ διὰ τεσσάρων . . . δεύτερον δέ, τὸ διὰ πέντε . . . τόνος δ' ἔστιν, ᾧ τὸ διὰ πέντε τοῦ διὰ τεσσάρων μείζον.* Cf. p. 21, *ἔστι δὴ τόνος ἡ τῶν πρώτων συμφώνων κατὰ μέγεθος διαφορά.*

² Gaudentius, *eisagoge*, 13, *τὸ δὲ ἡμιτόνιον καλούμενον οὐκ ἔστιν ἀκριβῶς ἡμιτόνιον.* Proclus, in *Timæum*, p. 191 D, E, *τὸ λεγόμενον ἡμιτόνιον, οὐ κυρίως ἡμιτόνιον.* Theon, *de musica*, 8, *τὸ μέντοι ἡμιτόνιον οὐχ ὡς ἡμισυ τόνου λέγεται, κ.τ.λ.* Censorinus, *de die natali*, 10, *abusivè hemitonion appellat.* Macrobius, in *somnium Scipionis*, ii. 1, *non ita accipiendum est (semitonium) ut dimidius tonus putetur.* Boetius, *de musica*, ii. 27, *videntur enim semitonia nuncupata, non quod vere tonorum sunt medietates, &c.* Theon and Macrobius proceed to a comparison with the *ἡμίφωνον* or *semivocale*.

the same effect in other passages. And outside his writings, and those of his disciples, there is nothing to imply that any tempered scale was known in ancient times.

The third objection to this system of transcribing is therefore very serious. Not only are the notes within the octave reduced from twenty-one to twelve by making nine of them of equal pitch with others, but the remaining twelve are forced into the tempered scale; the result being that, whichever of the twenty-one is selected as a tonic, the other twenty must all be more or less inaccurate in pitch.

These errors would be avoided by transcribing the ancient letters into modern letters in the following way:—

ϝ Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ Ϻ ϻ ϼ Ͻ Ͼ Ͽ
e e₁ e₂ f f₁ f₂ g g₁ g₂ a a₁ a₂ b b₁ b₂ c c₁ c₂ d d₁ d₂ e e₁ e₂
 Ϙ ϙ Ϛ ϛ Ϝ ϝ Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ Ϻ ϻ ϼ Ͻ Ͼ Ͽ

Ω Ψ Χ Φ Υ Τ Σ Ρ Π Ο Ξ Ν Μ Λ Κ Ι Θ Η Ζ Ε Δ Γ Β Α
f f₁ f₂ g g₁ g₂ a a₁ a₂ b b₁ b₂ c c₁ c₂ d d₁ d₂ e e₁ e₂ f f₁ f₂
 Ϙ ϙ Ϛ ϛ Ϝ ϝ Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ Ϻ ϻ ϼ Ͻ Ͼ Ͽ

ϝ Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ Ϻ ϻ ϼ Ͻ Ͼ Ͽ	Ο' Ξ' Ν' Μ' Λ' Κ' Ι' Θ' Η' Ζ' Ε' Δ' Γ' Β' Α'
<i>g g₁ g₂ a a₁ a₂</i>	<i>b b₁ b₂ c c₁ c₂ d d₁ d₂ e e₁ e₂ f f₁ f₂</i>
Ζ Ϙ ϙ Ϛ ϛ Ϝ ϝ Ϟ ϟ Ϡ ϡ Ϣ ϣ Ϥ ϥ Ϧ ϧ Ϩ ϩ Ϫ ϫ Ϭ ϭ Ϯ ϯ ϰ ϱ ϲ ϳ ϴ ϵ ϶ Ϸ ϸ Ϲ Ϻ ϻ ϼ Ͻ Ͼ Ͽ	Κ' Ϙ' ϙ' Ϛ' ϛ' Ϝ' ϝ' Ϟ' ϟ' Ϡ' ϡ' Ϣ' ϣ' Ϥ' ϥ' Ϧ' ϧ' Ϩ' ϩ' Ϫ' ϫ' Ϭ' ϭ' Ϯ' ϯ' ϰ' ϱ' ϲ' ϳ' ϴ' ϵ' ϶' Ϸ' ϸ' Ϲ' Ϻ' ϻ' ϼ' Ͻ' Ͼ' Ͽ'

ϝ'
 Ϟ'
 ϟ'

The notes that are transcribed as *a, b, c, d, e, f, g* have enough in common with the modern notes A, B, C, D, E, F, G to make these letters useful as a guide to memory. A suffix ₁ or ₂ distinguishes the first and second supplementary notes, while the punctuation . and .. and .. distinguishes the octaves. So this modern lettering gives all the information that is given by the ancient lettering, and gives it in a simpler form.

II.

When a musical note is produced by the vibration of a string, its pitch depends upon the rate at which the string vibrates. And the rate of this vibration varies inversely with the length of the string, so long as the tension and the thickness of the string remain the same.

Thus, an Octave is produced by strings whose lengths are in the ratio of 1 to 2, a Fifth by those which have the ratio of 2 to 3, and a Fourth by those which have the ratio of 3 to 4. Suppose, then, that four strings are taken with a length of 6 inches, 8 inches, 9 inches, and 12 inches respectively. Then the 6-inch and the 12-inch strings will give an Octave, since the lengths are in the ratio of 1 to 2. The 6-inch and the 9-inch strings will give a Fifth, and so also will the 8-inch and 12-inch strings, the ratio being 2 to 3 in both these cases. The 6-inch and the 8-inch strings, and again the 9-inch and the 12-inch strings, will give a Fourth, the ratio being 3 to 4. And the 8-inch and the 9-inch strings will give a Tone, with the ratio of 8 to 9, since a Tone is represented by the difference between a Fourth and Fifth¹.

These simple ratios of 1 to 2 and 2 to 3 and 3 to 4 were used to fix the four chief notes of every octave, two near the middle and one at either end. And generally the ratio of 8 to 9, which is involved in those of 2 to 3 and 3 to 4, was used to fix the four remaining notes.

Between the two notes near the middle and the two at either end there were two intervals in which the ratio was 3 to 4. Now 3 to $3\frac{2}{3}$ and $3\frac{2}{3}$ to $3\frac{5}{4}$ each had the ratio of 8 to 9; or if these figures were multiplied by 64 in order to eliminate the fractions, 192 to 216 and 216 to 243 each had the ratio of 8 to 9, while 192 to 256 was in the ratio of 3 to 4. And thus the introduction of two intervals that had

¹ This is all demonstrated in due form by Euclid, *sectio canonicis*, propositions 6, 8, 12 and 13: also by Plutarch, *de musica*, 22, 23, and others.

the ratio of 8 to 9 into an interval that had the ratio of 3 to 4 produced an interval that had the ratio of 243 to 256. In other words, the introduction of two Tones into a Fourth produced the interval that technically was called a Diesis or Leimma and vulgarly a Semi-Tone.

Plato seems to have styled the interval a Leimma, though the word itself does not occur in any of his extant writings¹; and this name lived on beside the name of Semi-Tone, which probably was introduced by Aristoxenos². The earlier Pythagoreans had used the name of Diesis³.

When the first four notes of any octave were given by strings whose lengths were 192 and 216 and 243 and 256, the fifth note and the eighth note were given by strings whose lengths were 288 and 384 respectively; since 192 to 384 was in the ratio of 1 to 2, while 192 to 288 and 256 to 384 were in the ratio of 2 to 3, and 288 to 384 was in the ratio of 3 to 4. And as this interval was treated like that other interval in which the ratio was 3 to 4, the sixth and seventh notes were given by strings whose lengths were 324 and $364\frac{1}{2}$; since 288 to 324 and 324 to $364\frac{1}{2}$ each had the ratio of 8 to 9, while $364\frac{1}{2}$ to 384 was in the ratio of 243 to 256. These figures being multiplied by 2 in order to eliminate the fraction, the eight notes of the octave were given by strings whose lengths were 384 and 432 and 486 and 512 and 576 and 648 and 729 and 768 respectively.

If these eight notes were taken in order of descent, the pitch decreasing as the length increased from 384 to 768, the intervals were Tone, Tone, Leimma; Tone; Tone, Tone,

¹ Plato, *Timæus*, p. 36 A, B, ἡμολίων δὲ διαστάσεων καὶ ἐπιτρίτων καὶ ἐπογδοῶν γενομένων ἐκ τούτων τῶν δεσμών ἐν ταῖς πρόσθεν διαστάσει, τῷ τοῦ ἐπογδοῦ διαστήματι τὰ ἐπίτριτα πάντα συνεπληροῦτο, λείπων αὐτῶν ἐκάστου μόριον, τῆς τοῦ μορίου ταύτης διαστάσεως λειψθείσης ἀριθμοῦ πρὸς ἀριθμὸν ἐχούσης τοῦς ὄρους σνς' πρὸς σμγ'. This use of λείπων and λειψθείσης seems to involve the use of λείμμα. cf. Macrobius, in *somnium Scipionis*, ii. 1, *Plato semitonium λείμμα vocitavit*.

² See above, page 8 and note 2.

³ Nicomachos, *encheiridion*, 9, 12, Stobæos, *eclogæ*, i. 21. 7, and Boetius, *de musica*, iii. 8, quote sayings of Philolaos in which this interval is styled a *δiesis*; and Theon, *de musica*, 12, and Macrobius, in *somnium Scipionis*, ii. 1, remark this usage of the term among his followers.

Leimma—there being a ratio of 8 to 9 for every Tone and 243 to 256 for every Leimma. But in the scales the Hypo-Lydian group put *e* a Fourth above *b* and a Fifth above *a*, and the Hypo-Phrygian group put *d* a Fourth above *a* and a Fifth above *g*, while the Hypo-Dorian group put *c* a Fourth above *g* and a Fifth above *f*¹. And thus, as a Tone was the difference between a Fourth and a Fifth and a Leimma was the difference between two Tones and a Fourth, the eight notes *e, d, c, b, a, g, f, e* were separated by the intervals of Tone, Tone, Leimma; Tone; Tone, Tone, Leimma. So these eight notes, or their equivalents in the octaves up above, were given by strings whose lengths were in the ratios just described.

A supplementary note was placed in every Tone by reckoning the ratio for the Tone as 16 to 18 in place of 8 to 9, and thereby bringing in the ratios of 16 to 17 and 17 to 18². And commonly the name of Semi-Tone was given to both the intervals that were created in this way, although the first of them was rather more than half a Tone and the second was rather less. But technically the first was known as an Apotome and the second as a Leimma³.

As there were five Tones in every Octave, these ratios of 16 to 17 and 17 to 18 introduced five supplementary notes. And as the Tones were *e* to *d*, *d* to *c*, *b* to *a*, *a* to *g* and *g* to *f*, these supplementary notes belonged to *d*, *c*, *a*, *g* and *f*. But the scales all show that *d*₂, *c*₂, *a*₂, *g*₂ and *f*₂ were the only supplementary notes that had to stand a Fourth or Fifth away from one or other of the original notes: so these must represent the supplementary notes that were inserted in the middle of each Tone.

¹ The scales are all given by Alypius, eisagoge. See below, page 18.

² Plutarch, de animæ procreatione, 18. Aristides, de musica, iii. 1. Ptolemy, harmonica, i. 10. Boetius, de musica, i. 16, iii. 1. Proclus, in Timæum, p. 195 A.

³ A λείμμα and ἀποτομή together made a Tone, and the ἀποτομή was larger than the λείμμα—see Gaudentius, eisagoge, 14; Boetius, de musica, ii. 29; Proclus, in Timæum, p. 195 D—so that, if the λείμμα took the ratio of 17 to 18, the ἀποτομή would get the ratio of 16 to 17. And this was probably the genuine λείμμα, the interval of ratio 243 to 256 being properly a *δίεσις*. Thus in Theon, de musica, 36, the interval of ratio 243 to 256 is distinguished as τὸ δίεσιαιὸν λείμμα.

Two more supplementary notes might then have been inserted in each Tone by doubling the ratios of 16 to 17 and 17 to 18, and bringing in the ratios of 32 to 33 and 33 to 34 within the ratio of 32 to 34 and the ratios of 34 to 35 and 35 to 36 within the ratio of 34 to 36¹. But the notation shows that only one more supplementary note was placed in every Tone; and as d_1 came between d_2 and d , c_1 between c_2 and c , a_1 between a_2 and a , g_1 between g_2 and g , and f_1 between f_2 and f , the ratios of 34 to 35 and 35 to 36 were those that fixed the five notes d_1 , c_1 , a_1 , g_1 and f_1 .

The interval that had the ratio of 35 to 36 was smaller than the interval that had the ratio of 34 to 35; and the whole interval of ratio 34 to 36 was smaller than the interval of ratio 32 to 34 that was required to complete the Tone. So these little intervals were far from being a quarter of a Tone apiece, although they generally were reckoned as such². The usual name for them was *Diesis*, but originally they bore the name of *Diaschisma*³.

If similar methods were employed in dealing with the intervals in which the ratio was 243 to 256, one supplementary note was inserted there by doubling this ratio and bringing in the ratios of 486 to 499 and 499 to 512, and then another was inserted by doubling the latter ratio and bringing in the ratios of 998 to 1011 and 1011 to 1024. And as $c b$ and $f e$ were the intervals in which the ratio was 243 to 256, the first of these supplementary notes was b_2 or e_2 and the second was b_1 or e_1 .

The eight original notes being given by strings whose lengths were 384 and 432 and 486 and 512 and 576 and 684 and 729 and 768 respectively, the following list will show the lengths required for all the supplementary notes, the figures being multiplied by 4 in order to get rid of fractions:—

¹ Aristeides, de musica, iii. 1.

² Thus, for example, Baccheios, eisagoge, 8, and Vitruvius, de architectura, v. 4, make a *diesis* a quarter of a Tone. Aristeides, de musica, iii. 1, and Proclus, in Timæum, p. 191 E, remark the error.

³ Boetius, de musica, iii. 8, quoting Philolaos, *diaschisma (est) dimidium dieseos*. Cf. note 3 on page 11 for *diesis* in Philolaos.

1536, <i>e</i> .	1728, <i>d</i> .	1944, <i>c</i> .	2048, <i>b</i> .
	1680, <i>d</i> ₁ .	1890, <i>c</i> ₁ .	2022, <i>b</i> ₁ .
	1632, <i>d</i> ₂ .	1836, <i>c</i> ₂ .	1996, <i>b</i> ₂ .
2304, <i>a</i> .	2592, <i>g</i> .	2916, <i>f</i> .	3072, <i>e</i> .
2240, <i>a</i> ₁ .	2520, <i>g</i> ₁ .	2835, <i>f</i> ₁ .	3033, <i>e</i> ₁ .
2176, <i>a</i> ₂ .	2448, <i>g</i> ₂ .	2754, <i>f</i> ₂ .	2994, <i>e</i> ₂ .

Having some doubts about the working of a scale constructed in this way, the author requested Messrs. Broadwood to procure for him a series of ten tuning-forks to represent the notes from *e* to *b*. The length of the strings was enough to fix the relative pitch of all the notes, but there was nothing to fix the absolute pitch of any one of them. For convenience, however, the author reckoned the pitch of *e* at 324 double vibrations per second, and thus obtained the following pitch for the remaining notes, the rate of vibration varying inversely as the length of string:—

<i>e</i> , 324	<i>d</i> , 288	<i>c</i> , 256	<i>b</i> , 243
	<i>d</i> ₁ , $296\frac{8}{5}$	<i>c</i> ₁ , $263\frac{11}{8}$	<i>b</i> ₁ , $246\frac{126}{1011}$
	<i>d</i> ₂ , $304\frac{16}{17}$	<i>c</i> ₂ , $271\frac{1}{17}$	<i>b</i> ₂ , $249\frac{165}{98}$

Or, putting the fractions into decimals,

<i>d</i> ₁ , 296.23	<i>c</i> ₁ , 263.31	<i>b</i> ₁ , 246.12
<i>d</i> ₂ , 304.94	<i>c</i> ₂ , 271.06	<i>b</i> ₂ , 249.33

The tuning-forks were made at Sheffield by Messrs. Valantine and Carr, and were tested by the makers on a Tonometer of their own. After they were delivered to Messrs. Broadwood, they were tested again by Mr. Hipkins on the late Mr. Ellis's copy of the Scheibler Tonometer, now in the Science Department of the South Kensington Museum¹. And these were the results:—

<i>e</i> , 323.43	<i>d</i> , 287.20	<i>c</i> , 255.64	<i>b</i> , 242.24
	<i>d</i> ₁ , 295.33	<i>c</i> ₁ , 262.45	<i>b</i> ₁ , 245.37
	<i>d</i> ₂ , 304.45	<i>c</i> ₂ , 270.35	<i>b</i> ₂ , 248.52

¹ The author is greatly indebted to Messrs. Broadwood, and especially to Mr. Hipkins, for taking such trouble in the matter.

In every instance the rate of the vibrations is rather less than was demanded. But the error is never more than $\cdot 90$ and never less than $\cdot 36$; and being always in the same direction, it has scarcely any effect upon the relative position of the notes.

Excepting the group of b, b_1, b_2 , the notes all come out clearly at intervals that can easily be recognized; and the sequence is exceedingly melodious. But when b or b_1 or b_2 is sounded by itself, there is some difficulty in saying which of them it is; although the difference is obvious enough when they are sounded in succession.

Now, the length of the strings for b_1 and b_2 was settled on the supposition that the intervals of ratio 243 to 256 were treated like the intervals of ratio 8 to 9. As the lengths $8\frac{1}{2}$ and $8\frac{3}{4}$ were taken between 8 and 9, the lengths $249\frac{1}{2}$ and $252\frac{3}{4}$ were taken between 243 and 256; and as these figures were raised to 34 and 35 between 32 and 36 in the first case, they were raised to 998 and 1011 between 972 and 1024 in the second case, in order to eliminate the fractions. Suppose, however, that the fraction was eliminated from $252\frac{3}{4}$ by the simpler process of ignoring the $\frac{3}{4}$ altogether, and treating the length as 252. Some very curious results will follow.

The intervals bb_1 and ee_1 will then be determined by the ratio of 252 to 256, or 63 to 64. The intervals dd_1, cc_1, aa_1, gg_1 and ff_1 are determined by the ratio of 35 to 36. And an interval of ratio 35 to 36 becomes an interval of ratio 63 to 64 on subtraction of the well-known interval of ratio 80 to 81.

Taking 2016 in place of 2022 and 3024 in place of 3033 as the lengths for b_1 and e_1 , and then examining the seven original notes and the seven with suffix₁, there is the ratio of 1 to 2 in $ee, e_1e_1, ff, \&c.$, the ratio of 2 to 3 in $eb, e_1b_1, fc, \&c.$, the ratio of 3 to 4 in $ea, gc, g_1c_1, \&c.$, the ratio of 4 to 5 in g_1b_1 and c_1e_1 , the ratio of 5 to 6 in e_1g_1 and b_1d_1 , the ratio of 6 to 7 in e_1g and b_1d , the ratio of 7 to 8 in ab_1 and de_1 , the ratio of 8 to 9 in $fg, f_1g_1, ga, \&c.$, the ratio of 9 to 10 in a_1b_1 and d_1e_1 , the ratio of 15 to 16 in e_1f_1 and b_1c_1 , the ratio of 27 to 28 in e_1f and b_1c , the ratio of 27 to 32 in $eg, ac, a_1c_1, \&c.$, the ratio of 35 to 36 in $ff_1, gg_1, aa_1,$

&c., and the ratio of 243 to 256 in *ef* and *bc*. Hence, with b_1 and e_1 in those positions, these fourteen notes involve the fourteen most important ratios that Ptolemy employs in his arrangement of the scales¹. But seven of these fourteen ratios depend on b_1 and e_1 .

The four original notes *b, c, d, e* are separated by intervals of ratio 243 to 256, 8 to 9 and 8 to 9, and thus produce the ordinary Tetrachord of the Pythagoreans, which Ptolemy called the Diatonic Tetrachord of Eratosthenes, and retained in his own system as the Double-Tone Diatonic². The four supplementary notes b_1, c_1, d_1, e_1 are separated by intervals of ratio 15 to 16, 8 to 9 and 9 to 10, and thus produce the Tetrachord that Ptolemy described as the Severe Diatonic³. But the four notes b_1, c, c_1, e_1 are separated by intervals of ratio 27 to 28, 35 to 36 and 4 to 5, and thus produce what Ptolemy called the Enharmonic Tetrachord of Archytas. And such coincidences make it fairly certain that b_1 and e_1 have now been put into their proper places.

Setting aside the Tetrachords that Ptolemy ascribes to Aristoxenos—their structure being questionable—there are sixteen other ratios employed in his arrangement of the scales. But all these ratios may be derived from those already quoted. Thus the ratio of 9 to 10 gives rise to those of 18 to 19 and 19 to 20, and to those of 38 to 39 and 39 to 40. The ratio of 5 to 6 gives rise to those of 10 to 11 and 11 to 12, and to those of 20 to 21 and 21 to 22. The ratio of 15 to 16 gives rise to those of 30 to 31 and 31 to 32; and this ratio of 15 to 16 with that of 14 to 16, or 7 to 8, produces the ratio of 14 to 15. Again, the ratio of 243 to 256 with that of 224 to 256, or 7 to 8, produces the ratio of 224 to 243. The ratio of 15 to 19 would come from those of 19 to 20 and 15 to 20, or 3 to 4. And the ratios of 45 to 46, 23 to 24 and 24 to 25, or 46 to 48 and 48 to 50, might be obtained from that of 45 to 50, or 9 to 10.

As an adjustment of b_1 and e_1 brought in seven of Ptolemy's

¹ Ptolemy, *harmonica*, ii. 14.

² Διάτονον διτονιαῖον.

³ Διάτονον σύντονον.

ratios in addition to the seven that already were involved in the original notes and those with suffix $_1$, the probabilities are that some of the remaining ratios could be obtained by a proper adjustment of b_2 and e_2 and the introduction of the other notes with suffix $_2$. But the author has not been fortunate enough to find a likely place for b_2 or e_2 .

The length of 252 was obtained for b_1 and e_1 by ignoring the $\frac{3}{4}$ in $252\frac{3}{4}$; and this suggests that the $\frac{1}{2}$ in $249\frac{1}{2}$ might be ignored in dealing with b_2 and e_2 . Again, the ratio for $b b_1$ and $e e_1$ has been converted into 256 to 252, or 64 to 63; and this suggests that the ratio for $b_1 b_2$ and $e_1 e_2$ may possibly be 252 to 248, or 63 to 62. But neither 249 nor 248, nor any other number in that neighbourhood, seems to give a satisfactory result.

If the ratio of 248 to 256, or 31 to 32, is used provisionally for determining the intervals $b b_2$ and $e e_2$, the lengths of string will have to be reduced from 1996 and 2994 to 1984 and 2976 for b_2 and e_2 . And the lengths for b_1 and e_1 have already been reduced from 2022 and 3033 to 2016 and 3024.

Then, supposing that an octave of twelve mean Semi-Tones is reckoned as 1200, the intervals $e e_1$ and $b b_1$ may be reckoned as 27 apiece, $e_1 e_2$ and $b_1 b_2$ as 28 apiece, and $e_2 f$ and $b_2 c$ as 35 apiece; $f f_1$, $g g_1$, $a a_1$, $c c_1$ and $d d_1$ as 49 apiece, $f_1 f_2$, $g_1 g_2$, $a_1 a_2$, $c_1 c_2$ and $d_1 d_2$ as 50 apiece, and $f_2 g$, $g_2 a$, $a_2 b$, $c_2 d$ and $d_2 e$ as 105 apiece¹. And then the ancient notes may be arranged as follows:—

0, e . 204, d . 408, c . 498, b . 702, a . 906, g . 1110, f . 1200, e .
 155, d_1 . 359, c_1 . 471, b_1 . 653, a_1 . 857, g_1 . 1061, f_1 . 1173, e_1 .
 105, d_2 . 309, c_2 . 443, b_2 . 603, a_2 . 807, g_2 . 1011, f_2 . 1145, e_2 .

According to Alypius, the scales were formed of eighteen notes apiece; and there were five-and-forty scales in all, or fifteen scales of three types each—diatonic, chromatic, and enharmonic. But in the chromatic and enharmonic types the notes were just the same; and in the diatonic type the only

¹ The formula $\frac{2000}{x} \times (\log. x - \log. y) \times 40$ gives the number of mean Semi-Tones in an interval of ratio x to y .

variation was in notes 4, 7, 10, 14 and 17. Putting the diatonic notes for 4 and 7 and 10 in brackets, and omitting the notes from 12 to 18, as these are only a repetition of the notes from 2 to 8 an octave higher up, the entire system is reducible to this:—

	I	2	3	4	(4)	5	6	7	(7)	8	9	10	(10)	II
HYPO-DORIAN	<i>f</i>	<i>g</i>	<i>g</i> ₁	<i>g</i> ₂	(<i>a</i> ₂)	<i>c</i>	<i>c</i> ₁	<i>c</i> ₂	(<i>d</i> ₂)	<i>f</i>	<i>f</i> ₁	<i>f</i> ₂	(<i>g</i> ₂)	<i>a</i> ₂
HYPO-IASTIAN	<i>f</i> ₂	<i>g</i> ₂	<i>a</i>	<i>a</i> ₂	(<i>b</i>)	<i>c</i> ₂	<i>d</i>	<i>d</i> ₂	(<i>e</i>)	<i>f</i> ₂	<i>g</i> ₂	<i>g</i> ₂	(<i>a</i>)	<i>b</i>
HYPO-PHRYGIAN	<i>g</i>	<i>a</i>	<i>a</i> ₁	<i>a</i> ₂	(<i>c</i>)	<i>d</i>	<i>d</i> ₁	<i>d</i> ₂	(<i>f</i>)	<i>g</i>	<i>g</i> ₁	<i>g</i> ₂	(<i>a</i> ₂)	<i>c</i>
HYPO-ÆOLIAN	<i>g</i> ₂	<i>a</i> ₂	<i>b</i>	<i>b</i> ₂	(<i>c</i> ₂)	<i>d</i> ₂	<i>e</i>	<i>e</i> ₂	(<i>f</i> ₂)	<i>g</i> ₂	<i>a</i>	<i>a</i> ₂	(<i>b</i>)	<i>c</i> ₂
HYPO-LYDIAN	<i>a</i>	<i>b</i>	<i>b</i> ₁	<i>b</i> ₂	(<i>d</i>)	<i>e</i>	<i>e</i> ₁	<i>e</i> ₂	(<i>g</i>)	<i>a</i>	<i>a</i> ₁	<i>a</i> ₂	(<i>c</i>)	<i>d</i>
DORIAN	<i>a</i> ₂	<i>c</i>	<i>c</i> ₁	<i>c</i> ₂	(<i>d</i> ₂)	<i>f</i>	<i>f</i> ₁	<i>f</i> ₂	(<i>g</i> ₂)	<i>a</i> ₂	<i>b</i>	<i>b</i> ₂	(<i>c</i> ₂)	<i>d</i> ₂
IASTIAN	<i>b</i>	<i>c</i> ₂	<i>d</i>	<i>d</i> ₂	(<i>e</i>)	<i>f</i> ₂	<i>g</i> ₂	<i>g</i> ₂	(<i>a</i>)	<i>b</i>	<i>b</i> ₁	<i>b</i> ₂	(<i>d</i>)	<i>e</i>
PHRYGIAN	<i>c</i>	<i>d</i>	<i>d</i> ₁	<i>d</i> ₂	(<i>f</i>)	<i>g</i>	<i>g</i> ₁	<i>g</i> ₂	(<i>a</i> ₂)	<i>c</i>	<i>c</i> ₁	<i>c</i> ₂	(<i>d</i> ₂)	<i>f</i>
ÆOLIAN	<i>c</i> ₂	<i>d</i> ₂	<i>e</i>	<i>e</i> ₂	(<i>f</i> ₂)	<i>g</i> ₂	<i>a</i>	<i>a</i> ₂	(<i>b</i>)	<i>c</i> ₂	<i>d</i>	<i>d</i> ₂	(<i>e</i>)	<i>f</i> ₂
LYDIAN	<i>d</i>	<i>e</i>	<i>e</i> ₁	<i>e</i> ₂	(<i>g</i>)	<i>a</i>	<i>a</i> ₁	<i>a</i> ₂	(<i>c</i>)	<i>d</i>	<i>d</i> ₁	<i>d</i> ₂	(<i>f</i>)	<i>g</i>
HYPER-DORIAN	<i>d</i> ₂	<i>f</i>	<i>f</i> ₁	<i>f</i> ₂	(<i>g</i> ₂)	<i>a</i> ₂	<i>b</i>	<i>b</i> ₂	(<i>c</i> ₂)	<i>d</i> ₂	<i>e</i>	<i>e</i> ₂	(<i>f</i> ₂)	<i>g</i> ₂
HYPER-IASTIAN	<i>e</i>	<i>f</i> ₂	<i>g</i> ₂	<i>g</i> ₂	(<i>a</i>)	<i>b</i>	<i>b</i> ₁	<i>b</i> ₂	(<i>d</i>)	<i>e</i>	<i>e</i> ₁	<i>e</i> ₂	(<i>g</i>)	<i>a</i>
HYPER-PHRYGIAN	<i>f</i>	<i>g</i>	<i>g</i> ₁	<i>g</i> ₂	(<i>a</i> ₂)	<i>c</i>	<i>c</i> ₁	<i>c</i> ₂	(<i>d</i> ₂)	<i>f</i>	<i>f</i> ₁	<i>f</i> ₂	(<i>g</i> ₂)	<i>a</i> ₂
HYPER-ÆOLIAN	<i>f</i> ₂	<i>g</i> ₂	<i>a</i>	<i>a</i> ₂	(<i>b</i>)	<i>c</i> ₂	<i>d</i>	<i>d</i> ₂	(<i>e</i>)	<i>f</i> ₂	<i>g</i> ₂	<i>g</i> ₂	(<i>a</i>)	<i>b</i>
HYPER-LYDIAN	<i>g</i>	<i>a</i>	<i>a</i> ₁	<i>a</i> ₂	(<i>c</i>)	<i>d</i>	<i>d</i> ₁	<i>d</i> ₂	(<i>f</i>)	<i>g</i>	<i>g</i> ₁	<i>g</i> ₂	(<i>a</i> ₂)	<i>c</i>
	I	2	3	4	(4)	5	6	7	(7)	8	9	10	(10)	II

Of course, these scales all differ in pitch, like the modern scales of different keys. But they do not differ, like the modern scales of different modes, in the order of the intervals alone. The difference here involves the nature of the intervals as well.

For example, in the Phrygian scale of c the only supplementary notes with suffix $_1$ are d_1 and g_1 and c_1 , with d_1 and g_1 in the octave up above; and these are all determined by the ratios of the Tone. But the Lydian scale of d has e_1 and e_1 , which are determined by the ratios of the Leimma, as well as a_1 and d_1 and a_1 , which come from Tones. And thus the Lydian scale admits the well-known intervals of 231, or ratio 7 to 8, in $d e_1$ and $d e_1$, of 267, or ratio 6 to 7, in $e_1 g$ and $e_1 g$, and finally of 182, or ratio 9 to 10, in $d_1 e_1$, which is thus a minor Tone. And in the Phrygian scale these intervals are not to be obtained.

Thus, in passing from the Phrygian to the Lydian scale there was a change of mode as well as key; and a change of mode had more effect in ancient than in modern music, since it varied the selection of the intervals.

No doubt the Lydian music differed from the Phrygian in many things besides this raising of the pitch from cc to dd and the admission of these intervals of ratio 6 to 7 and 7 to 8 and 9 to 10; for the Phrygian was accounted fit for warriors on the field of battle, while the Lydian was consigned to lazy banquetting¹. But presumably the change of mode and key together helped to make these different types of music arouse such different emotions.

In several of these scales some curious intervals are formed by the connexion of the Leimma with the segments of the Tone, such as that of 195, or ratio 243 to 272, in $a_2 c$ at the beginning of the Dorian scale. As a rule, the scales began with major Tones of 204, or ratio 8 to 9. But in a scheme of Ptolemy's for seven scales to suit the seven notes within an octave, the seven intervals of ratio 7 to 8, 8 to 9, 9 to 10, &c., are taken in turn for the beginning of the scales²: so this rule was not imperative. And there is really no justification for altering the place of a_2 to make $a_2 c$ a major Tone, or for tampering with the other notes that incidentally produce abnormal intervals.

¹ Plato, *politeia*, pp. 398 E, 399 A.

² Ptolemy, *harmonica*, ii. 11.

A couple of examples will suffice to show the nature of the music that was extracted from the ancient notes.

In the first of the Hymns from Delphi the passage about *κλυτὰ μεγαλόπολις Ἀθθῆς* has the notes *f, g, g₁, g, c₂, c₁, c, b¹*. Here the voice ascends 204, ascends 49, descends 49, descends 603, descends 50, descends 49, descends 90. The transcript gives F, G, A flat, G, D, D flat, C, B. And there the voice ascends 200, ascends 100, descends 100, descends 500, descends 100, descends 100, descends 100.

Again, in the second of these Hymns the words *δεξάμενος ἀμβρόταν* have the notes *d, b, b₁, d, e, e₁, e²*. Here the voice descends 294, ascends 27, ascends 267, ascends 204, ascends 27, descends 27. The transcript gives D, B, C, D, E, F, E. And there the voice descends 300, ascends 100, ascends 200, ascends 200, ascends 100, descends 100.

In fact, the charm of ancient melodies was in the subtle variation of the intervals through which they rose and fell; and all their charm is sacrificed when they are forced into a modern scale.

III.

The duration of the notes was indicated by the syllables to which they were attached. And thus, if syllables in verse are classed as long and short, and a short is reckoned as half a long, this mode of reckoning must be adopted for the notes as well.

For example, take the music for the twelfth of the Homeric Hymns³. The notes may not be quite so ancient as the words; but they can scarcely be condemned as spurious, although their pedigree is incomplete.

¹ Bulletin de Correspondance Hellénique, vol. xvii. plate 21 *bis*, and vol. xviii. plate 25.

² Ibid., vol. xviii. plates 12 *bis* and 20.

³ Published in 1724 by Benedetto Marcello in his *Parafrafi sopra li primi venticinque Salmi*, vol. iii. p. 132.

$\dot{d} \dot{d} \dot{d} \dot{e}_1 \dot{e} \dot{d} \dot{d} \dot{b}_1 \dot{b}_1 \dot{e}_1 \dot{g} \dot{e}_1 \dot{e}_1 \dot{e}_1 \dot{e} \dot{a}$
 Δήμητρ' ἠύκομον, σεμνήν θεόν, ἄρχομ' ἀείδειν,

$\underline{a} \underline{g} \underline{g} \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e} \underline{d} \underline{d} \underline{d} \underline{g} \underline{g} \underline{b}_1$
 Αὐτήν, καὶ κούρην, περικαλλέα Περσεφόνην.

$\dot{b}_1 \dot{b}_1 \dot{b}_1 \dot{b}_1 \dot{b}_1 \dot{b}_1 \dot{b}_1 \dot{e}_1 \dot{e}_1 \dot{e}_1 \dot{e}_1 \dot{e} \dot{e} \dot{e} \dot{e} \dot{a}$
 Χαίρε, θεά, καὶ τήνδε σάω πόλιω' ἄρχε δ' αἰοιδίης.

In the first and last lines the long syllables at the end are sung to two notes each, and must therefore be reckoned as pairs of short syllables in dealing with the music. And thus, with the ordinary signs for long and short, the music is

$\bar{d} \bar{d} \bar{d} \check{e}_1 \check{e} \bar{d} \bar{d} \bar{b}_1 \bar{b}_1 \check{e}_1 \check{g} \check{e}_1 \check{e}_1 \check{e}_1 \check{e} \check{a}$
 $\underline{a} \underline{g} \underline{g} \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e}_1 \underline{e} \underline{d} \underline{d} \underline{d} \underline{g} \underline{g} \underline{b}_1$
 $\bar{b}_1 \bar{b}_1 \bar{b}_1 \bar{b}_1 \bar{b}_1 \bar{b}_1 \bar{b}_1 \check{e}_1 \check{e}_1 \check{e}_1 \check{e}_1 \check{e} \check{e} \check{e} \check{e} \check{a}$

But this is only a succession of long notes with short notes of exactly half their length; and although a succession of Minims and Crotchets, or Crotchets and Quavers, may be suitable enough in music that has nothing but the Tones and Semi-Tones of equal temperament, some refinement is required here in music that involves the Diesis, Apotome, &c.

In all probability the duration of the notes was governed by some such rules as those that governed the pitch, for Hexameters were curiously like Octaves¹. Roughly speaking, there were six Tones in an Octave, just as there were six Feet in a Hexameter; a Tone contained a pair of Semi-Tones, or one Semi-Tone and a pair of Quarter-Tones, just as a Foot was either a Spondee of two long syllables or a Dactyl of one long and two short; and the Fourth and Fifth divided the Octave into two Tones and a half and three and a half, just as the Cæsura divided the Hexameter into two Feet and a half and three and a half. But, strictly

¹ The comparison is suggested by Aristeides, de musica, i. 14, 23.

speaking, the Octave was divided into two Tones and a Leimma and three and a Leimma in place of two and a half and three and a half, since the whole was rather less than six entire Tones; and in every Tone the first of the so-called Semi-Tones and Quarter-Tones was rather larger than the second. Hence a Spondee would have made the first note rather longer than the second, while a Dactyl would have made the first note rather longer than the second and third together, and also made the second rather longer than the third. The long note before the Cæsura and the long note at the end would each have been abbreviated to represent a Leimma, and likewise the pairs of short notes that occasionally were used in place of them. But obviously the analogy is somewhat strained.

No doubt the duration of the notes was modified to some extent by their position in the verse; and the signs for the Cæsura and the Foot should perhaps be added to the ordinary signs for long and short, as follows:—

$$\begin{array}{cccccccccccccccc} \bar{d} & \bar{d} & | & \check{e}_1 & \check{e}_2 & | & \bar{d} & || & \bar{d} & | & \check{b}_1 & \check{b}_2 & | & \check{e}_1 & | & \check{g} & | & \check{e}_1 & \check{e}_2 & | & \check{e}_1 & \check{e}_2 & | & \check{a} \\ \bar{a} & \check{g} & | & \check{g} & \check{e}_1 & | & \check{e}_2 & || & \check{e}_1 & \check{e}_2 & | & \check{e}_1 & \check{e}_2 & | & \check{a} & | & \bar{d} & \check{d} & | & \check{g} & | & \check{g} & \check{b}_1 \\ \check{b}_1 & \check{b}_2 & | & \check{b}_1 & \check{b}_2 & | & \check{b}_1 & \check{b}_2 & | & \check{e}_1 & \check{e}_2 & | & \check{e}_1 & \check{e}_2 & || & \check{e}_1 & \check{e}_2 & | & \check{e}_1 & \check{e}_2 & | & \check{e}_1 & \check{e}_2 & | & \check{a} \end{array}$$

But possibly it would be better to give the words themselves, for this formidable array of signs only touches the duration of the notes so far as that was settled by the rhythm of the verse.

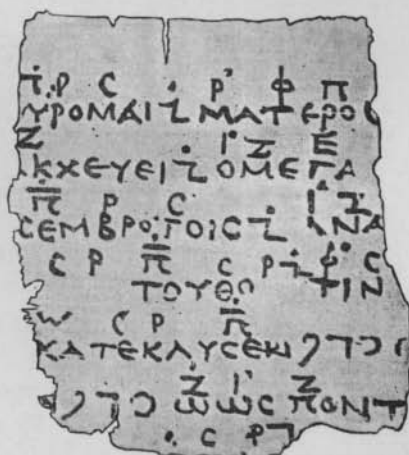
A system of dots and dashes is employed in two of the surviving bits of ancient music to determine the duration of the notes or their intensity. There is a fragment of papyrus at Vienna¹ with a few notes of the music for the *Orestes* of Euripides. The verses are—

κατολοφύρομαι, κατολοφύρομαι,
ματέρος αἶμα σᾶς, ὄ σ' ἀναβακχέει;

¹ Mittheilungen aus der Sammlung der Papyrus Erzherzog Rainer, vol. v. p. 66.

ὁ μέγας ὄλβος οὐ μόνιμος ἐμ βροτοῖς·
 ἀνὰ δὲ λαΐφος ὥς
 τις ἀκάτου θοᾶς τινάξας δαίμων
 κατέκλυσεν δεινῶν πόνων ὥς πόντου κ.τ.λ.¹

In the papyrus the verses are divided by a species of *κορωνίς* in the shape of Z; and there is always a dot above this Z and a dot behind the note that follows. Thus there is a \dot{Z} to divide *κατολοφύρομαι* from *ματέρος*, and a P· to give the note for *μα*: so also a \dot{Z} to divide *ἀναβακχεύει* from *ὁ μέγας*, and an I· to give the note for *ὁ*; and again a \dot{Z} to divide *βροτοῖς* from *ἀνὰ*, and an I· to give the note for *ἀ*. But evidently the scribe was puzzled by the half-verse *ἀνὰ δὲ λαΐφος ὥς* and completed it with *τις ἀκάτου θοᾶς*, putting a \dot{Z} above the line to divide *θοᾶς* from *τινάξας* and a Φ· to give the note for *τι*, as though this were the beginning of another verse. And having thus lost the guidance of the metre, he makes a long scrawl after *κατέκλυσεν*, and tries to start another verse at *ὥς πόντου* by adding \dot{Z} and I· above the line.



Apparently there was a dot and dash ÷ to mark the first note of the fourth Foot in every verse. This is distinctly

¹ Verses 338-343.

visible above the note for ἐμ in ἐμ βροτοῖς at the end of the third verse, above the note for του in ἀκάτου θοᾶς, which is treated here as the end of the fourth verse, and above the note for σε in κατέκλυσε, as though the scribe were trying to make the fifth verse end with κατέκλυσε πόνων in order to begin the sixth with ὡς πόντου. There is also a trace of it above the note for φηρ in κατολοφύρομαι at the end of the first verse; but nothing can be seen above the note for βακ in ἀναβακχέει at the end of the second¹. In this verse, however, the penultimate is long, whereas the other verses make it short; and possibly the sign was not required here.

The fragment is not large enough to give the first note of the second or third Foot in any of the verses, except the note for κατ in κατέκλυσε, which must be treated here as the beginning of the third Foot in the fifth verse. But there is not any sign above this note.

The system is varied in a song inscribed on stone in honour of a man named Seikilos². His monument was found at Tralles, and is now at Smyrna.

ā	ē	ē	c ₂ dē	ḋ	ċ ₂ ḋ	ē	ḋċ ₂	ḃ	ā	ḣġ	ā		
ὄσον	ζῆς,	φαίνου·	μηδὲν	ὄλωσ	σὺ	λυποῦ·	πρὸς						
c ₂ e	ḋ	ċ ₂ ḋ	ċ ₂	ā	ḣġ	ā	ċ ₂ ḃ	ḋ	ē	ċ ₂	ā	ā	aḟżē
ὀλίγον	ἐστὶ	τὸ	ζῆν·	τὸ	τέλος	ὁ	χρόνος	ἀπαιτεῖ.					

Excepting the first three words, this can be arranged in verses of one type, as follows:—

μηδὲν ὄλωσ σὺ λυποῦ·	—	—	—	—	—
πρὸς ὀλίγον ἐστὶ τὸ ζῆν·	—	—	—	—	—
τὸ τέλος ὁ χρόνος ἀπαιτεῖ.	—	—	—	—	—

The sign $\overset{\cdot}{\cdot}$ is used here, like the sign \dot{Z} in the papyrus, as a species of κορωνίς for marking off the verses; and there is always a dash—above the last note of the third Foot, just as

¹ The author has examined the papyrus.

² Bulletin de Correspondance Hellénique, vol. xviii. plate 13.

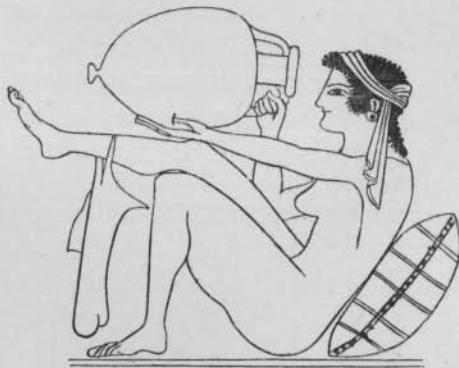
the papyrus has a dot and dash $\dot{-}$ above the first note of the fourth Foot. Thus the words ὄσον ζῆς must form a verse apart, as they answer to the endings of these other verses, σὺ λυποῦ, τι τὸ ζῆν, ἀπαιτεῖ. And then the word φαίνον will also form a verse apart. There is a dot underneath the κορώνις at the end of this little verse $\dot{-}$, and a dash — above the first note in the verse that follows, although no dash or dot is given to the first note in the other verses. And some dots may be observed above the three notes of the second Foot in the longer verses at the end, whereas the papyrus has only a dot behind the first note of each verse.

There is altogether such a difference between the system in the papyrus and the system on this stone, that no valid rules can be established for the distribution of the dots and dashes. But obviously the system is only meant to show the rhythm of the verses, for the position of all these signs is determined by the metre. In reality no signs were needed for this purpose; and none were used in the remaining bits of ancient music. Of course, such signs might possibly have been omitted in the copying of pieces that are only known through manuscripts; but the Hymns discovered at Delphi are originals on stone, and they have not these dots and dashes.

While the metre may have varied the duration of the notes that normally were classed as long or short, it must certainly have varied their intensity; for no rhythm can have its full effect unless some stress is laid upon the syllables that come at certain stages of the verse. So this lengthening or shortening of the notes would be attended by an increase or a decrease in their strength. Apart from this, the entire melody might grow louder or softer in successive parts of an elaborate piece, and the time might likewise grow faster or slower; but there is nothing to indicate such changes.

Thus it is impossible to fix the absolute pitch, duration or intensity of any of the ancient notes. The evidence only goes to prove that certain notes were higher or lower, longer or shorter, louder or softer than certain other notes. And in dealing with their relative pitch, duration and intensity, the pitch alone can be determined with precision.

There is consequently a serious fault in much that has been written of late about the music of the ancients. Transcripts have been made upon a plan that necessarily gives the wrong pitch to twenty notes out of every twenty-one and does not necessarily give the right pitch to the twenty-first, while it probably is just as much at fault in the duration of the notes and their intensity. Arguments have been founded on these transcripts, as though all originals had now been superseded; and the conclusions are astonishing. In fact, some ancient music has actually been compared to works of Beethoven and Wagner, from which it differs fundamentally. But this was perhaps to be expected when so many scholars and musicians have plunged into a higher criticism of ancient music without taking the trouble to make themselves acquainted with the notes.



A FLUTE-PLAYER, TAKING A DRINK, WITH HER FLUTE-CASE SLUNG OVER HER LEG.

From a Greek vase in the Author's collection.

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